Saskatchewan
Environment and
Public Safety

Water Quality
Branch

Assiniboine River Water Quality

Influence of Kamsack Effluent Discharges (1991)

WQ 149
June, 1992

ASSINIBOINE RIVER WATER QUALITY-

INFLUENCE OF KAMSACK EFFLUENT DISCHARGES (1991)

Water Quality Branch
Saskatchewan Environment and
Public Safety
WQ # 146
June, 1992

TABLE OF CONTENTS

FOREWORD iii

LIST OF TABLES iv

LIST OF FIGURES v

SUMMARY vi

RECOMMENDATION vii

1.0 INTRODUCTION 1

2.0 BACKGROUND INFORMATION 1
2.1 THE ASSINIBOINE RIVER BASIN IN SASKATCHEWAN 1
2.2 INVESTIGATION OF THE EXISTING DATABASE 3

3.0 STUDY OBJECTIVES 4

4.0 SAMPLING SITES AND METHODOLOGY 5

5.0 RESULTS AND DISCUSSION 5
5.1 SPRING MONITORING PROGRAM 6
5.1.1 IMPACT OF SPRING DISCHARGE ON THE RIVER WITH RESPECT TO SEPS SURFACE WATER QUALITY OBJECTIVES 7
5.1.1.1 AMMONIA 7
5.1.1.2 NUTRIENTS 8
5.1.1.3 BACTERIOLOGICAL DATA 8
5.1.2 NUTRIENT LOADING RESULTING FROM THE SPRING DISCHARGE 9
5.1.3 IMPACT OF THE SPRING DISCHARGE ON PPWB'S HIGHWAY #8 MONITORING SITE 12
5.1.4 THE WATER QUALITY OF THE SPRING SEWAGE EFFLUENT 14
5.2 THE FALL MONITORING PROGRAM 15
5.2.1 IMPACT OF THE FALL EFFLUENT ON THE ASSINIBOINE RIVER IN RELATION TO SEPS SURFACE WATER QUALITY OBJECTIVES 16
5.2.2 NUTRIENT LOADING RESULTING FROM THE FALL EFFLUENT RELEASE 17
5.2.3 EFFECTS OF FALL DISCHARGE ON PPWB'S HIGHWAY #8 MONITORING SITE 18
5.2.4 THE WATER QUALITY OF THE FALL EFFLUENT . . 19

6.0 CONCLUSIONS 21

LITERATURE CITED 23

ACKNOWLEDGEMENTS 24

LIST OF APPENDICES 25

FOREWORD

In 1990 representatives of the Water Quality Branch of Saskatchewan Environment and Public Safety, Manitoba Environment and the Prairie Provinces Water Board (PPWB) met to discuss water quality issues in the Assiniboine River Basin. The Branch agreed to undertake a monitoring study to determine the influence of treated sewage effluent discharges upon the water quality of the Assiniboine River near Kamsack, Saskatchewan. The study involved monitoring the spring and fall 1991 effluent discharges and the river reach starting near Kamsack to the Manitoba-Sakatchewan border.

The major objectives of the study included:

1. To monitor the 1991 spring and fall effluent releases by the town of Kamsack into the Assiniboine River. To assess the impact of these releases upon the river with respect to water uses and users. To verify that the resultant river water quality complied with the SEPS surface water quality objectives.
2. To provide Manitoba with an indication of potential nutrient loadings from the effluent to the Shellmouth Reservoir.
3. To determine if the nutrient data collected by PPWB (Assiniboine River at Highway #8, near Kamsack) could be affected by Kamsack's effluent releases.

LIST OF TABLES

Table 1: Kamsack Final Sewage Effluent Release Dates

Table 2: The Study Sampling Sites and Schedule

Table 3: Spring and Fall Monitoring Program Parameters Sampled, Parameter Codes and Analytical Laboratories

Table 4: Daily Discharge Data for 1991 from the Assiniboine River at Highway #5 (Kamsack)

Table 5: Ammonia Exceedences During the Spring Discharge

Table 6: Total Phosphorous Loading Summary

LIST OF FIGURES

Figure 1: Assiniboine River Saskatchewan Basin Map

Figure 2: Assiniboine River Total Phosphorous Data Collected by PPWB at Assiniboine River at Highway #8 near Kamsack

Figure 3: Map Showing the Location of the Sampling Sites

Figure 4: Discharge-Velocity Curve for Assiniboine River at Highway #5 (Kamsack)

Figure 5: Total Nitrogen (TN) Concentrations Between Leftbank, Centre, and Rightbank Sites at Highway #8 during the Spring Study

Figure 6: Total Suspended Solids (TSS) Concentrations Between Leftbank, Centre and Rightbank Sites at Highway #8 during the Spring Study

Figure 7: Total Phosphorous Concentrations from all Assiniboine River Sites Sampled during the Spring Study

Figure 8: Conductivity and Total Dissolved Solids (TDS) of the Spring Final Sewage Effluent

Figure 9: Conductivity and Total Dissolved Solids (TDS) of the Fall Final Sewage Effluent

SUMMARY

In 1991 a study was conducted by Saskatchewan Environment and Public Safety, Water Quality Branch to:

1. Determine the impact of effluent discharges on water quality and water uses in the Assiniboine river downstream of the Town of Kamsack.
2. Determine the potential influence of the effluent discharges upon water quality at the Prairie Provinces Water Board (PPWB) monitoring station at Highway #8 near Kamsack.
3. Obtain data by which spring and fall nutrient loading of the river and the effluent discharges could be estimated and provide Manitoba with an indication of nutrient loading to Shellmouth Reservoir.

The results of this study showed that both the spring and fall effluent discharges had minimally impacted the Assiniboine River. The water quality in the river during the discharges met the provincial surface water quality objectives for all water uses occurring in this reach of the river. An exception was ammonia during the spring release. The study data also indicated that water quality at the PPWB monitoring station at Highway #8 near Kamsack was influenced by the effluent discharges.

Total phosphorous loadings that resulted from the spring and fall effluent discharges were estimated. Approximately 963 kilograms of phosphorous were discharged into the Assiniboine River during the spring effluent release. About 103 kilograms of phosphorous were added as a result of the fall effluent release. Together the two effluent releases accounted for 34% of the total 1991 loading at the PPWB (Highway #8) monitoring station. Although the effluent related loading was significant in 1991, the total flows in the river were substantially below those which characterize the river in most years. A recomendation was made with respect to the Department examining opportunities for extended treatment of sewage to improove the quality of the spring discharges.

Estimates for total phosphorous loadings from the river were calculated during the spring and fall programs for two sites, the PPWB station and at Highway #357 near the Manitoba border and reservoir. The spring monitoring program results showed that during the effluent release periods, the Highway #8 site yielded higher daily phosphorus loadings than Highway #357. These results indicated that the Highway #357 site likely provided a more representative evaluation of the water quality which crosses the Saskatchewan-Manitoba border. A further recommendation was made stating that the Highway #8 site may not be representative of the temporal nutrient conditions at the border as a result of the spring and fall discharges from the Town of Kamsack and that PPWB should confirm the suitability of the Highway #8 site for future monitoring.

RECOMMENDATIONS

Two recommendations resulted from this study:

1. Saskatchewan Environment and Public Safety should investigate opportunities for extended treatment of municipal effluent from the Town of Kamsack to improve the quality of the spring discharges.

2. The Prairie Provinces Water Board (PPWB) should be made aware that the water quality at the PPWB monitoring station at Highway #8 near Kamsack is influenced by effluent discharges by the Town of Kamsack. Data collected at this monitoring site may not be representative of the water quality of the Assiniboine River. The PPWB should confirm the suitability of the Highway #8 site for future monitoring.

1.0 INTRODUCTION

Saskatchewan Environment and Public Safety (SEPS) was approached by Manitoba Environment in the spring of 1990 to provide water quality information related to a proposed two year trophic modelling study of Shellmouth Reservoir, Manitoba. The major tributary discharging into Shellmouth Reservoir is the Assiniboine River. The Assiniboine River receives seasonal (spring and fall) discharges of treated municipal effluent from the Town of Kamsack. These biannual discharges enter the river at a location just three kilometers (km) upstream of the Prairie Provinces Water Board's (PPWB) interprovincial water quality monitoring station. The Water Quality Branch of SEPS agreed to undertake a monitoring study in the spring and the fall of 1991, to measure the impact of the effluent on the river and on the PPWB monitoring station and also to measure the nutrient loading to Shellmouth Reservoir. This report presents the findings of these studies.

2.0 BACKGROUND INFORMATION

2.1 THE ASSINIBOINE RIVER BASIN IN SASKATCHEWAN

The Assiniboine River basin in Saskatchewan encompasses an area of 16,612 km^2 (Figure 1). The basin contains a population of 60,000, two-thirds of which live in urban centres. The largest centre being the City of Yorkton. The basin is situated in a prime North American nesting and breeding area for ducks and therefore, many duck habitat enhancement projects have been constructed in the

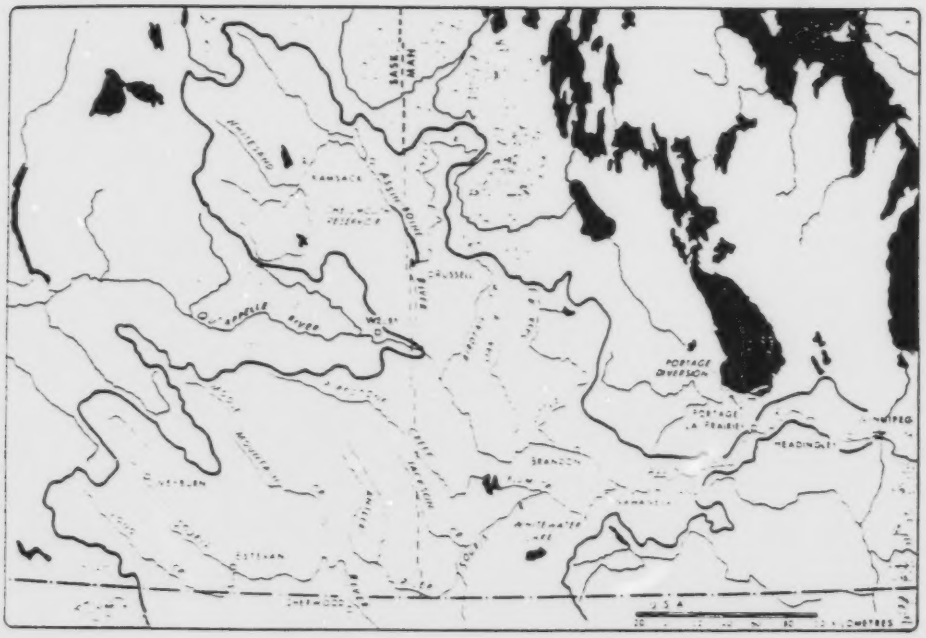


Figure 1: Assiniboine River Saskatchewan Basin Map

Lane,R.K and Sykes,G.N. 1982.

basin. The topography of the basin is gentle to moderately undulating. The original dominant natural vegetation was that of Aspen Grove section of the Boreal Forest region, but most of the native grassland is now cultivated. The main economic activity in the basin is farming. The major crops are mixed grains and wheat with some lands in pasture and hay. There is very little irrigation. There is considerable livestock in the basin.

The river is classified as an intermittent stream (Lane and Sykes,1982). Annual peak flows are highly variable resulting mainly from the spring snowmelt runoff. Flow decreases rapidly after snowmelt and is sustained primarily by groundwater. In dry years the flow may decrease to zero during the summer and fall. It is a transboundry river whose headwaters originate in Saskatchewan, 54 km northwest of the town of Preeceville. The river flows in a southeasterly direction for 147 km before joining its major tributary, the Whitesand River near Kamsack. It then continues its southeasterly course for 45 km where it enters the province of Manitoba. At the Saskatchewan and Manitoba border it enters the head waters of Shellmouth Reservoir, an impoundment formed by the daming of the Assiniboine and Shell Rivers. Below this reservoir the river reaches its terminous at the Red River in Manitoba. The Shellmouth dam creates a reservoir named "The Lake of the Prairies" but which will be refered to as the Shellmouth Reservoir in this report. This lake is 56 km long and extends partially into Saskatchewan. The impoundment was constructed in 1972 to provide flood protection as well as to insure cooling water for Manitoba

Hydro's thermal electric generating station at Brandon.

This transboundry waterway is important for a number of reasons. It is a popular recreational area which supports a profitable sport fishery as the walleye harvest from the reservoir has traditionally been high. The sports fishery alone has been estimated to generate local revenues in excess of $1,000,000 per year. It also provides domestic and agricultural water supplies for communities in both provinces.

2.2 INVESTIGATION OF THE EXISTING DATABASE

The Prairie Provinces Water Board (PPWB) has been collecting monthly data on the Assiniboine River at Highway #8 near Kamsack, Saskatchewan since before the Shellmouth dam was built. A preliminary investigation of this database revealed some concerns. The PPWB monitoring site at Highway #8 is located less than three river kilometres downstream of the effluent discharge point for the Town of Kamsack's biannual discharges regulated by SEPS. Analysis of the existing PPWB database revealed that some of the data may have been affected by these effluent discharges. Some unusually high values for total phosphorous (TP) data were recorded during the fall (Figure 2), which seemed to correspond with the Town's biannually permitted releases (Table 1).

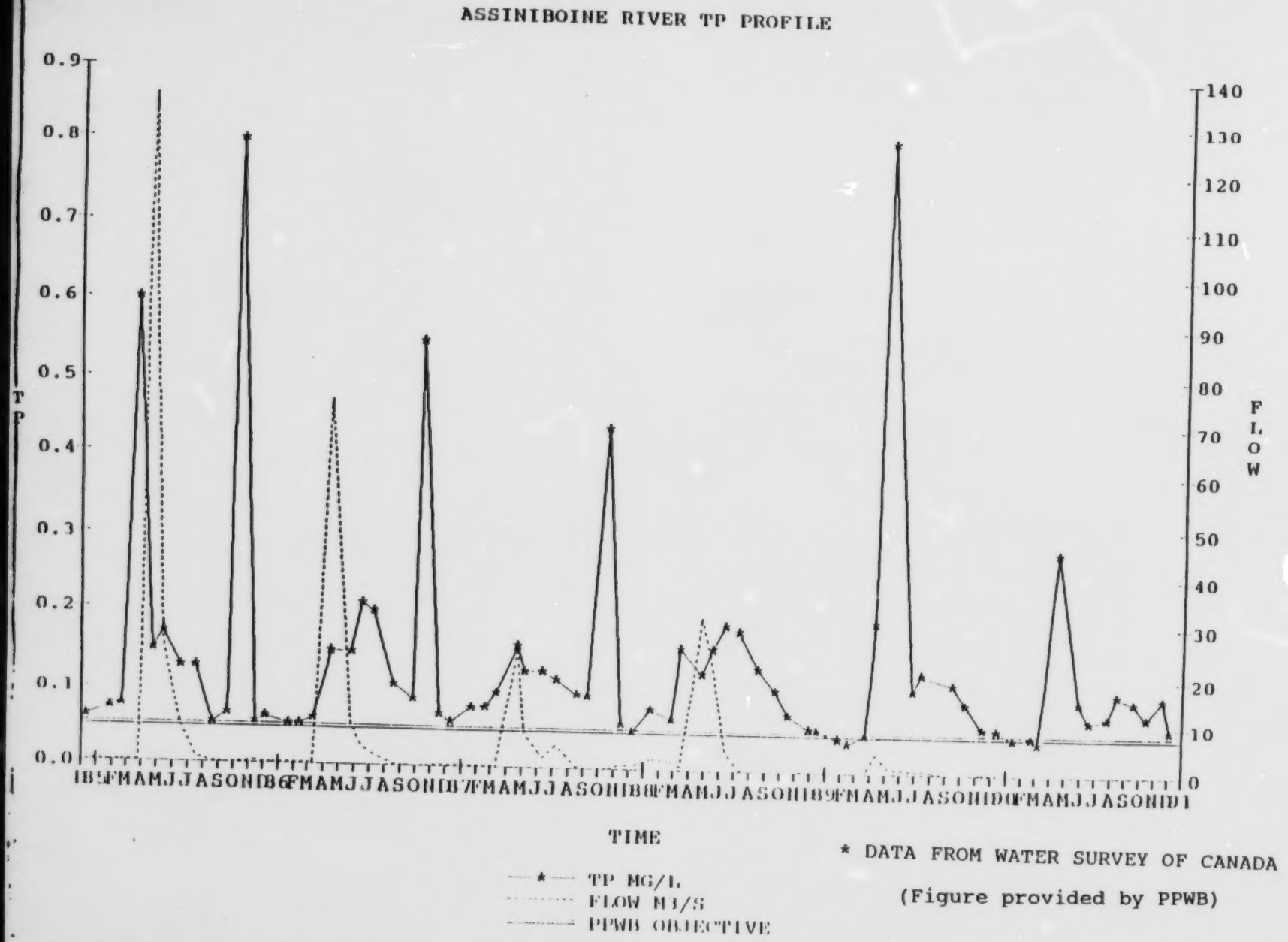
Table 1: Kamsack Final Sewage Effluent Release Dates

Kamsack Final Sewage Effluent Collection Dates*	
Date	**Time**
23-04-85	14:30
21-10-85	17:00
28-04-86	09:30
14-11-86	13:30
20-04-87	13:30
13-10-87	13:30
17-05-88	11:00
12-10-88	11:00
09-05-89	14:30
17-10-89	14:15
16-04-90	10:00
17-10-90	08:00

* These dates indicate times when samples were collected during release. The total release time is around these dates plus or minus approximately 10 - 14 days.

* DATA FROM SEPS PROVINCIAL LABORATORY

Figure 2: Assiniboine River Total Phosphorous Data Collected by PPWB at Assiniboine River at Highway #8 near Kamsack



* DATA FROM WATER SURVEY OF CANADA

(Figure provided by PPWB)

3.0 STUDY OBJECTIVES

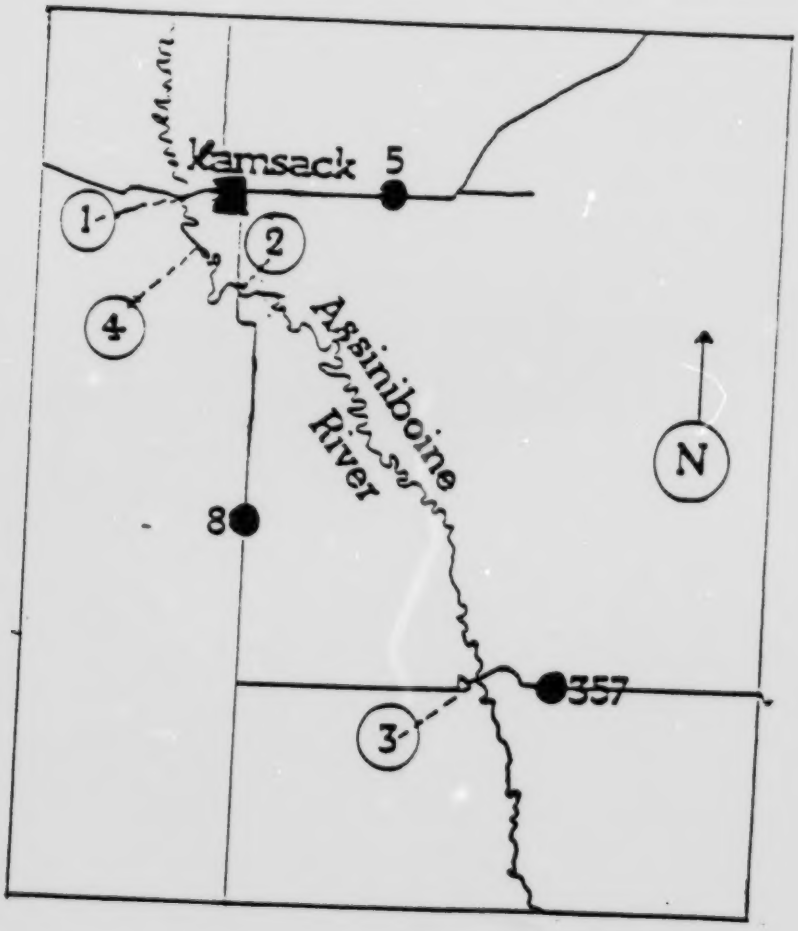
The objectives of this study were as follows:

1. To monitor the 1991 spring and fall effluent releases by the Town of Kamsack into the Assiniboine River.
2. To assess the impact of these releases upon the river with respect to water uses and users.
3. To verify that the resultant river water quality complied with SEPS surface water quality objectives.
4. To provide Manitoba with an indication of nutrient loadings (TP) to Shellmouth Reservoir.
5. To determine if the nutrient data collected by PPWB (Assiniboine River at Highway #8 near Kamsack) site, could be affected by Kamsack's effluent releases.

4.0 SAMPLING SITES AND METHODOLOGY

The study area and locations of the sampling sites, are shown in Figure 3. Appendix 1 is a collection of photographs of the sites. Water samples were collected before, during and after the sewage releases at sites above and below, the release area. Table 2 details the sampling sites and schedule. All procedures and equipment were in accordance with SEPS standards (1984). The two laboratories used were Environment Canada (Saskatoon) and SEPS Provincial Water Laboratory (Regina). Table 3 is a list of

Figure 3: Map Showing the Location of the Sampling Sites



SCALE: ONE CENTIMETER EQUALS TWO KILOMETERS.

Table 2: The Study Sampling Sites and Schedule

Site Description	Site Number	S=Spring F=Fall	1991 Dates Sampled
Assiniboine River at Highway #5 Bridge (Upstream Discharge)	1	SF	April 15, 17, 20, 22, 26, May 6/ Oct. 21, 23, 27, Nov. 5
Assiniboine River at Highway #8 Bridge (LDB) (downstream discharge)	2	SF	April 15, 17, 20, 22, 26, May 6/ Oct. 21, 23, 27, Nov. 5
Assiniboine River at Highway #8 Bridge (Center) (downstream discharge)	2	S	April 17, 20, 22, 26
Assiniboine River at Highway #8 Bridge (RDB) (downstream discharge)	2	S	April 17, 20, 22, 26
Assiniboine River at Highway #357 Bridge (downstream discharge)	3	SF	April 15, 17, 20, 22, 26, May 6/ Oct. 21, 23, 27, Nov. 5
Kamsack Sewage lagoon Final Effluent	4	SF	April 16, 17, 18, 20, 22, 25, 26, 27, Oct. 21, 23, 27, 28

Table 3: Spring and Fall Monitoring Program Parameters Sampled, Parameter Codes and Analytical Laboratories

Parameters	Parameter Codes	Analytical Lab	Season, S=Spring, F=Fall
Sulphate	16308L	P	SF
Ph	10301L	P	SF
Total Alkalinity	10109L	P	SF
Total Hardness	10602L	P	SF
Calcium Hardness	20109L	P	SF
Calcium	20100L	P	SF
Magnesium	10102L	P	SF
Chloride	17204L	P	SF
Sodium	11102L	P	SF
Bicarbonate	06201L	P	SF
Potassium	19102L	P	SF
TDS	00206L	P	SF
Conductivity	02041L	P	SF
BOD	08202L	P	SF
TKN	07016L	P	SF
Ammonia	07506L	P	SF
Nitrate	07109L	P	SF
TP	15409L	P	SF
OP	15206L	P	SF
TSS	10406L	P	SF
VSS	10521L	P	SF
FSS	10505L	P	SF
Total Coliforms	36002L01L	P	SF
Fecal Coliforms	36012L11L	P	SF
Fecal Strep	36102L	P	SF
DOC	06117L	P	SF
Dissolved Oxygen	08101F	P	SF
Field Ph	10301F	P	SF
Field Conductivity	02041F	P	SF
Water Temperature	02061F	P	SF
Dissolved Nitrogen	07651L	E	S
Ammonia	07540P	E	S
Nitrate/Nitrite	071101L	E	S
Part. Nitrogen	07901L	E	S
TP	15423L	E	SF
DP	15465L	E	S
OP	15265L	E	S
NFR	10401L	E	S
DOC	06104L	E	S

E - Environment Canada
P - SEPS

parameters, parameter codes and analytical laboratories. Each laboratory received "split" samples. The sewage effluent was sampled more frequently than were the river sites. For economic reasons, these extra effluent samples were sent only to the Saskatchewan provincial laboratory. Quality control "blanks" alternated with "duplicates" were submitted during each sampling trip.

During the fall program, right bank and centre sampling at the Highway #8 site (Site 2 from Figure 3) was not done. Also, only the total phosphorous (TP) samples were sent to and analyzed by the Environment Canada laboratory.

5.0 RESULTS AND DISCUSSION

The spring and fall monitoring programs were two separate programs and therefore the results for each program are discussed separately. The data used is presented in Appendix 2 (spring program) and Appendix 6 (fall program). Environment Canada results have been presented wherever possible, to maintain consistency with historical data collected by PPWB. Additional data from this study can be found in ESQUADAT((SEPS), Water Quality DataBase).

5.1 SPRING MONITORING PROGRAM

The Town of Kamsack began releasing their sewage lagoon effluent into the Assiniboine River on April 16, 1991, during the

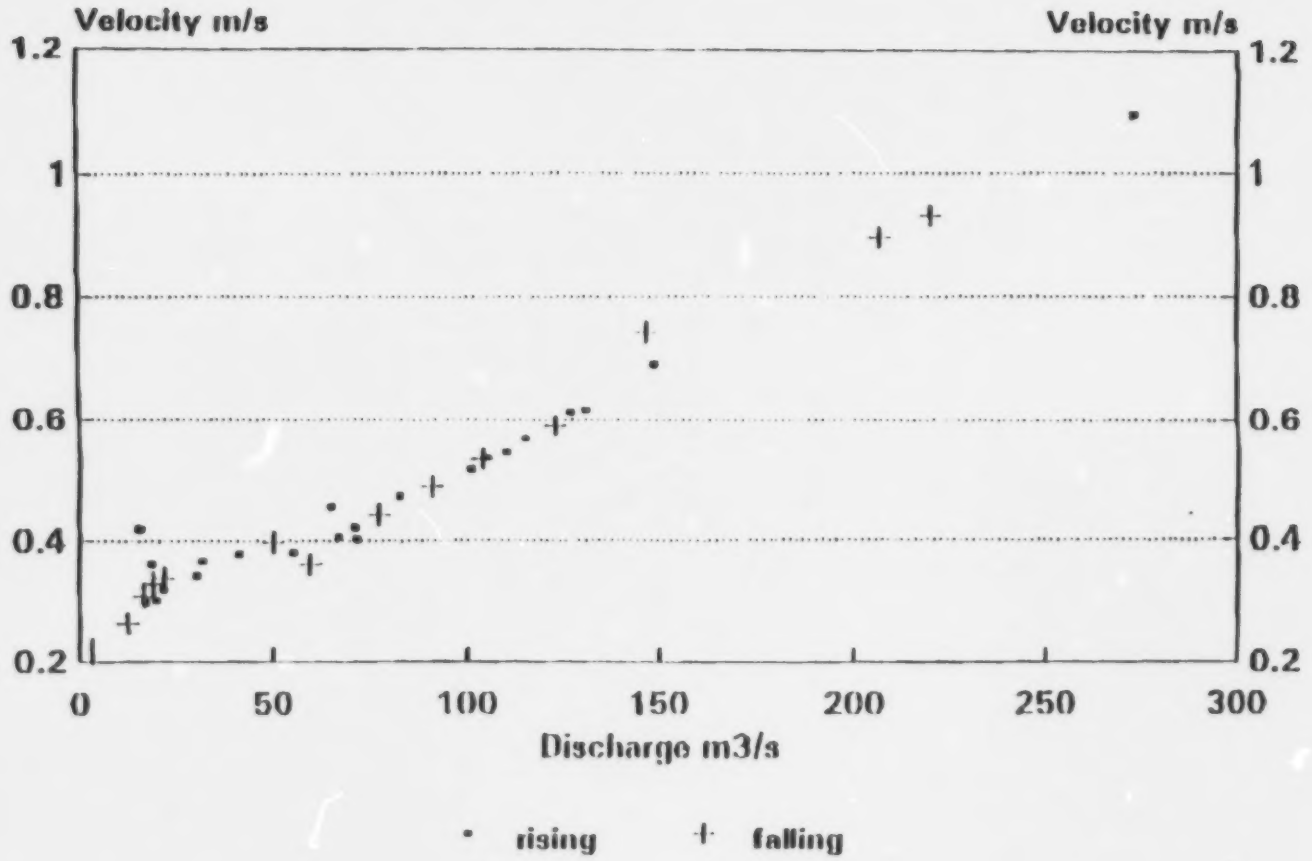
spring runoff. The timing of the release was in accordance with SEPS regulations. The discharge ended on April 30,1991 with an estimated 27.5 million imperial gallons (123,750,000 litres) released into the river (Dave Clark, Town of Kamsack, personal communication). The average rate of flow of the effluent was calculated by the writer to be 0.014 cubic meters per second (m^3/s). This equalled aproximately 0.5 % of the total river flow. During the period of discharge, the river flow decreased from 5.12 m^3/s on April 16 to a low of 1.7 m^3/s on April 30 (Table 4). The average flow during this period was 2.92 m^3/s.

From the discharge-velocity curve (Figure 4), a time of travel of twenty hours was estimated for the effluent to reach Highway #357, 16 kilometers downstream. The data indicates that the effluent had not reached this site when it was sampled on April 17, more than 24 hours after the release began (Appendix 2). Concentrations of parameters which are affected by organic effluent such as nutrients, sodium and chloride ions etc., showed no significant change over ambient values. The discharge-velocity curve will need to be calibrated for any future use at the Highway #357 site.

5.1.1 IMPACT OF SPRING DISCHARGE ON THE RIVER WITH RESPECT TO SEPS SURFACE WATER QUALITY OBJECTIVES

The data indicates that the impact of the effluent on the river, downstream of the discharge site was not significant with respect to major water uses and users (Appendix 2). The parameters

Figure 4: Discharge-Velocity Curve for Assiniboine River at Highway #5 (Kamsack) WATER SURVEY OF CANADA



* DATA FROM WATER SURVEY OF CANADA

Table 4: Daily Discharge Data for 1991 from the Assiniboine River at Highway #5(Kamsack)

WATER SURVEY OF CANADA
JAN 14 1992 PAGE 1
REGINA, SASK. 09:18

ASSINIBOINE RIVER AT KAMSACK

STATION NO. 05MD004

(PRELIMINARY) DAILY DISCHARGE IN CUBIC METRES PER SECOND FOR 1991

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	0.115 B	0.128 B	0.050 B	0.272 B	1.67	1.33	0.521	0.303	0.036	0.007	0.087	0.210	1
2	0.105 B	0.132 B	0.149 B	0.499 B	1.87	1.25	0.672	0.373	0.029	0.006	0.170	0.208	2
3	0.095 B	0.141 B	0.173 B	0.485 B	2.14	1.27	0.553	0.446	0.023	0.007	0.154	0.205	3
4	0.086 B	0.139 B	0.182 B	1.15 B	2.15	1.08	0.654	0.522	0.030	0.007	0.161	0.198	4
5	0.076 B	0.138 B	0.187 B	5.41 B	2.03	0.906	1.59	0.557	0.034	0.005	0.164	0.193	5
6	0.066 B	0.141 B	0.176 B	7.56 B	1.93	1.20	1.58	0.493	0.029	0.007	0.164	0.214	6
7	0.056 B	0.146 B	0.183 B	7.30 B	1.82	1.22	1.38	0.430	0.029	0.009	0.160	0.227	7
8	0.046 B	0.145 B	0.185 B	6.87 B	1.66	1.00	1.29	0.376	0.019	0.005	0.138	0.240	8
9	0.060 B	0.146 B	0.165 B	9.90 B	1.63	0.800	1.18	0.329	0.006	0.003	0.167	0.236	9
10	0.080 B	0.141 B	0.183 B	12.7 B	1.67	0.651	1.09	0.285	0.003	0.003	0.167	0.231	10
11	0.095 B	0.141 B	0.190 B	15.9 B	1.58	0.512	1.33	0.248	0.003	0.003	0.166	0.227	11
12	0.100 B	0.139 B	0.187 B	15.7	1.46	0.502	1.57	0.207	0.004	0.004	0.162	0.223	12
13	0.105 B	0.154 B	0.189 B	10.5	1.69	0.411	1.40	0.157	0.004	0.003	0.171	0.222	13
14	0.110 B	0.145 B	0.197 B	7.37	1.96	0.388	1.30	0.108	0.006	0.002	0.175	0.215	14
15	0.115 B	0.150 B	0.196 B	5.86	2.03	0.357	1.89	0.100	0.005	0.003	0.196	0.223	15
16	0.117 B	0.145 B	0.195 B	5.12	2.11	0.285	2.93	0.086	0.008	0.004	0.210	0.227	16
17	0.116 B	0.141 B	0.183 B	4.69	2.12	0.255	2.52	0.077	0.020	0.002	0.214	0.228	17
18	0.119 B	0.143 B	0.187 B	4.38	2.32	0.204	1.98	0.069	0.037	0.003	0.215	0.232	18
19	0.118 B	0.150 B	0.195 B	4.04	2.47	0.183	1.80	0.062	0.030	0.005	0.233	0.237	19
20	0.120 B	0.154 B	0.210 B	3.64	2.24	0.166	1.64	0.059	0.021	0.005	0.260	0.234	20
21	0.121 B	0.155 B	0.221 B	3.31	2.02	0.154	1.46	0.054	0.014	0.005	0.299	0.238	21
22	0.123 B	0.147 B	0.217 B	2.88	1.80	0.142	1.27	0.050	0.008	0.006	0.300	0.240	22
23	0.129 B	0.149 B	0.194 B	2.51	1.95	0.113	1.12	0.047	0.009	0.006	0.272	0.217	23
24	0.132 B	0.149 B	0.176 B	2.29	1.94	0.085	0.964	0.044	0.008	0.006	0.246	0.200	24
25	0.120 B	0.148 B	0.163 B	1.88	2.01	0.072	0.857	0.043	0.004	0.007	0.221	0.189	25
26	0.140 B	0.098 B	0.154 B	1.85	2.02	0.151	0.750	0.060	0.004	0.007	0.198	0.170	26
27	0.138 B	0.042 B	0.146 B	1.97	1.89	0.115	0.643	0.060	0.003	0.010	0.189	0.150	27
28	0.131 B	0.043 B	0.139 B	1.83	1.72	0.106	0.509	0.056	0.004	0.043	0.187	0.130	28
29	0.136 B		0.138 B	1.78	1.68	0.104	0.519	0.053	0.005	0.083	0.199	0.115	29
30	0.129 B		0.156 B	1.70	1.56	0.089	0.453	0.048	0.006	0.084	0.207	0.100	30
31	0.127 B		0.187 B		1.41		0.328	0.049		0.085		0.050	31
TOTAL	3.326	3.790	5.470	151.426	58.50	15.081	37.793	5.851	0.446	0.435	5.795	6.220	TOTAL
MEAN	0.107	0.135	0.176	5.05	1.89	0.503	1.22	0.189	0.015	0.014	0.193	0.201	MEAN
DAM3	287	327	473	13100	5050	1300	3270	506	38.5	37.6	501	537	DAM3
MAX	0.140	0.155	0.221	15.9	2.47	1.33	2.93	0.557	0.037	0.085	0.300	0.240	MAX
MIN	0.046	0.042	0.050	0.272	1.41	0.072	0.328	0.043	0.003	0.002	0.087	0.050	MIN

SUMMARY FOR THE MONTHS JAN TO DEC
MEAN DISCHARGE, 0.806 M3/S
TOTAL DISCHARGE, 23400 DAM3
MAXIMUM DAILY DISCHARGE, 15.9 M3/S ON APR 11
MINIMUM DAILY DISCHARGE, 0.002 M3/S ON OCT 14
MAXIMUM INSTANTANEOUS DISCHARGE 17.0 B M3/S AT 0447 C.S.T. APRIL 12

B-ICE CONDITIONS

that did exceed SEPS surface water quality objectives are described in detail in the following sections.

5.1.1.1 AMMONIA

Ammonia, which is formed mainly by the decomposition of nitrogenous organic matter, such as sewage in the water, exceeded SEPS surface water quality objectives (1988) for freshwater aquatic life. The guidelines were exceeded at both downstream sites during the release period. For example, on April 17 at the Highway #8 site, the ammonia value was 1.86 mg/L and the maximum acceptable value was 1.18 mg/L. The maximum acceptable levels and the exceedences are presented in Table 5. Concentrations returned to ambient levels after the discharge ended.

5.1.1.2 NUTRIENTS

Elevated levels of nutrients such as phosphorous and nitrogen were detected at both sites downstream of the release zone. At both the Highway #8 and Highway #357 sites, total phosphorous (TP) increased from less than 0.3 mg/L, to greater than 0.5 mg/L, during the period of effluent release (Figure 5 & Appendix 3). The levels returned to ambient after the release ended. The TP analysis differed between the two laboratories, probably because the labs use different analytical techniques. In general, the provincial laboratory yielded slightly higher results for TP than the

Table 5: Ammonia Exceedences During the Spring Discharge

Site	Date	Water Temp. Deg. Celcius	pH Units	Ammonia (mg/L)	Objective (mg/L)*
Assiniboine River at Hwy #8 Bridge (LDB) (downstream discharge)	April 17	6	7.9	1.86	1.18
	April 20	8	8.2	1.52	0.67
	April 22	7	8.8	1.0	0.22
Assiniboine River at Hwy #357 Bridge (downstream discharge)	April 22	8	8.6	0.6	0.37

* SOURCE SEPS GENERAL SURFACE WATER QUALITY OBJECTIVES (1988)

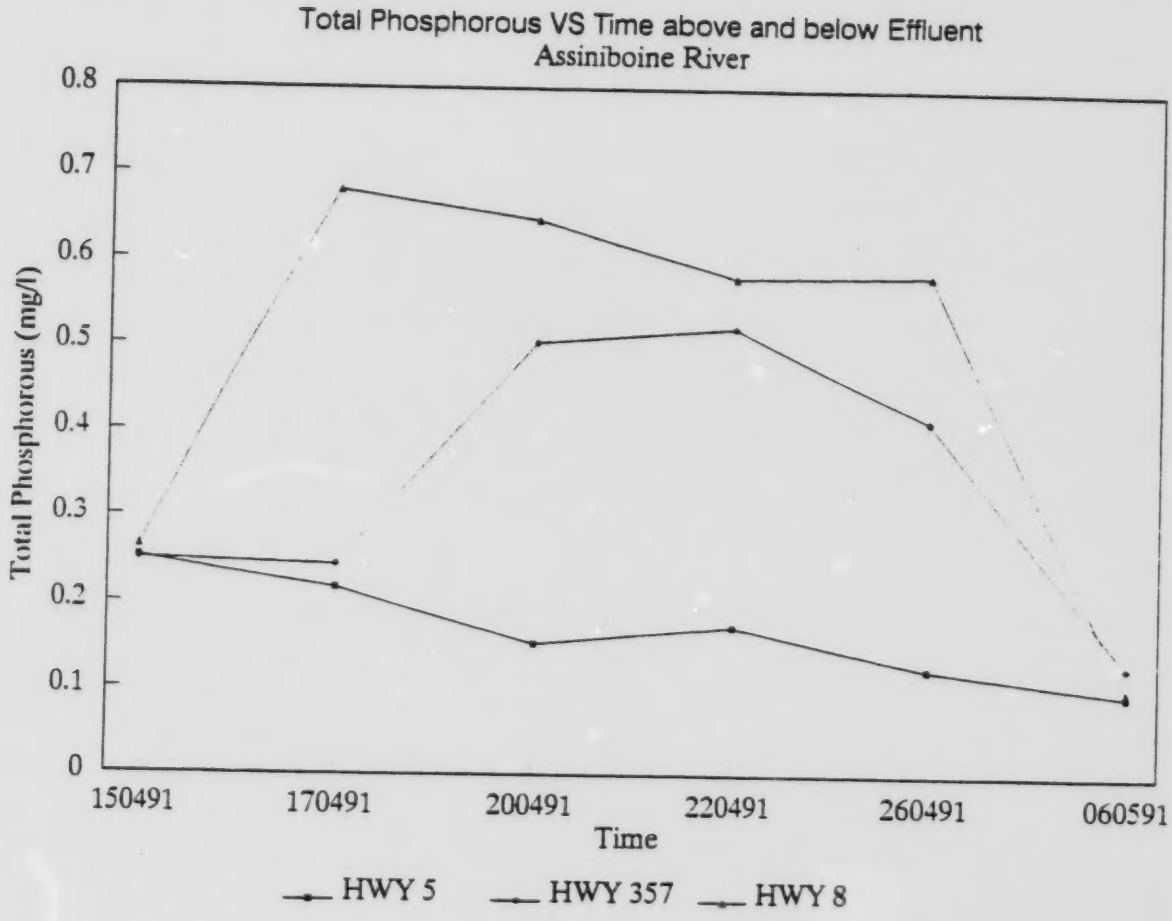


Figure 5: Total Phosphorous Concentrations from all Assiniboine River Sites Sampled during the Spring Study

Environment Canada lab results

Environment Canada laboratory.

5.1.1.3 BACTERIOLOGICAL DATA

The bacteriological measurements indicated a high concentration of bacteria in the sewage effluent (total coliform (TC) counts ranged from 15,000/100 ml. to 250,000/100 ml.) see Appendix 2. However, no exceedences to SEPS general surface water quality objectives (5000/100 ml. for TC and 1000/100 ml. for fecal coliform (FC)) were detected in the Assiniboine River. Bacteria counts were generally quite low at the river monitoring stations (150/100 ml or less).

These results are not readily explained. The dilution and/or rate of die off of bacteria in the relatively short river reach examined was not considered sufficient to lower the effluent concentrations to those observed in the river.

5.1.2 NUTRIENT LOADING RESULTING FROM THE SPRING DISCHARGE

The Town of Kamsack released 123,750,000 Litres (124,000m^3) of effluent into the Assiniboine River between April 16 and April 30. The average concentration of TP in the effluent was 7.78 mg/L (Appendix 2). This TP value is within the range of historical spring effluent data collected by SEPS (Appendix 9). The amount of phosphorous entering the Assiniboine River from the effluent was

estimated to be 962.8 kilograms (kg)/15 days or 64.2 kg/day.

The data presented in Appendix 2 clearly shows that the TP concentrations at the Highway #357 site are less than the Highway #8 site. This difference is important in terms of estimating the TP loading to Shellmouth Reservoir. For instance, during the entire spring monitoring program the average flow (Table 4) in the Assiniboine River was 2.79m^3/s and during the effluent release period it was 2.92m^3/s. The average TP concentration (Appendix 2) at the Highway #8 site (LDB), was 0.475 mg/L during the entire spring monitoring program, and 0.622 mg/L during the discharge period. With this information, the TP loading to the Shellmouth Reservoir from the river at the Highway #8 site was calculated. It equalled 114.5 kg/day for the entire spring program and 157.0 kg/day during the effluent discharge period. The TP loading increased by about 46% during the discharge period.

The same calculations were performed using the Highway #357 site data. During the entire spring monitoring program the TP loading was 82.7 kg\day. During the sewage discharge period the TP loading was 120.8 kg\day. The TP loading increased by about 37% during the discharge. These calculations prove that the Highway #8 site daily loadings were higher than the Highway #357 site daily loadings. They also demonstrate that the daily phosphorous loadings increased during the sewage discharge period at both sites.

The TP loadings from data collected during this study was then compared with TP and river discharge data collected at Highway #8 by PPWB in 1991, to determine the overall TP loading by the

effluent in relation to the total yearly loadings. The data needed to make this calculation was acquired via personal communication between the PPWB and the Saskatchewan Water Corporation and resulted in the following: in 1991 the mean daily discharge of the Assiniboine River at Highway #8 was 0.803m^3/s and; the mean concentration of TP, based on monthly samples, was 0.122 mg/L. This information was used to calculate the daily TP loading of 8.56 g/day from the Assiniboine River at Highway #8 site to Shellmouth Reservoir during 1991. The TP loading for the whole year was calculated to be 3,089.22 kg/year. Therefore, the TP loading from the spring 1991 release would have represented about 31.2% of the total 1991 yearly loading. However, 1991 was considered a below normal flow year and therfore, probably represented a worst case scenario. If, for example, the effluent was compared to 1990 (mean flow of 4.57 m/s and average TP concentration of 0.0993 mg/L), the resultant loading from the effluent would represent about 7.2% of the total yearly loading. Table 6 summarizes this TP loading information.

Another observation seen from the data collected during this study is that much of the TP loading occurs during the spring runoff. This is evident from the TP data collected at all three Assiniboine River sites sampled. The ambient TP values were high before the effluent release (just after the spring peak flows) compared to the ambient values after the discharge and spring runoff had ended. For example, at the Highway #5 site, TP on April 15 was 0.28 mg/L and on May 6, TP was 0.13 mg/L, the other sites

Table 6: Total Phosphorous Loading Summary

SITE	TIME FRAME	DAILY TP LOADING (IN KILOGRAMS)	YEARLY TP LOADIN (IN KILOGRAMS
ASSINIBOINE RIVER AT HIGHWAY#8 BRIDGE (LDB) (downstream discharge	DURING SPRING RELEASE (15 DAYS)	156.9	2354.6
	DURING ENTIRE SPRING STUDY (22 DAYS)	114.5	2518.9
	DURING ENTIRE FALL STUDY OCTOBER 21 to NOVEMBER 5	0.994	15.9
	DURING ENTIRE YEAR (1991) (365 DAYS)	8.6	3089.2
	DURING ENTIRE YEAR (1990) (365 DAYS)	36.8	13446.2
ASSINIBOINE RIVER AT HIGHWAY #357 BRIDGE (downstream discharge	DURING SPRING RELEASE (15 DAYS)	120.8	1812.6
	DURING ENTIRE SPRING STUDY (22 DAYS)	82.7	1818.9
KAMSACK SEWAGE LAGOON	DURING SPRING RELEASE (15 DAYS)		962.8
	DURING FALL RELEASE * OCTOBER 21-29		102.7

* DATA FROM SEPS PROVINCIAL LAB

showed similar trends (Figure 5). These values, coupled with the increased spring flows, would probably result in significant TP loading during the runoff. More intensive monitoring of the spring runoff is needed in order to obtain a more accurate estimate of the increased nutrient loading that occurs into Manitoba during the spring runoff. Since PPWB is responsible for determining the loadings which cross provincial borders, it is suggested that they revise their Assiniboine River monitoring program to better quantify nutrient loading during spring runoff events.

5.1.3 IMPACT OF THE SPRING DISCHARGE ON PPWB'S HIGHWAY #8 MONITORING SITE

Examination of the historical data (sampled by PPWB) revealed a concern that the effluent would not be completely mixed at the Assiniboine River Highway #8 sampling site. Also, it was suspected that the data collected for the past 20 years may have been influenced by these biannual effluent releases.

To determine the extent of the mixing, left and right bank and centre sampling was done at this site. Results are presented, graphically, in Appendix 4. The data indicates very little lateral difference in the concentrations of most parameters (for example see Figure 6). A few parameters, in particular total suspended solids (TSS), chloride and sulphate did show some differences. TSS was generally higher during most of the release period, at the left downstream bank (LDB). The right downstream bank (RDB) and centre

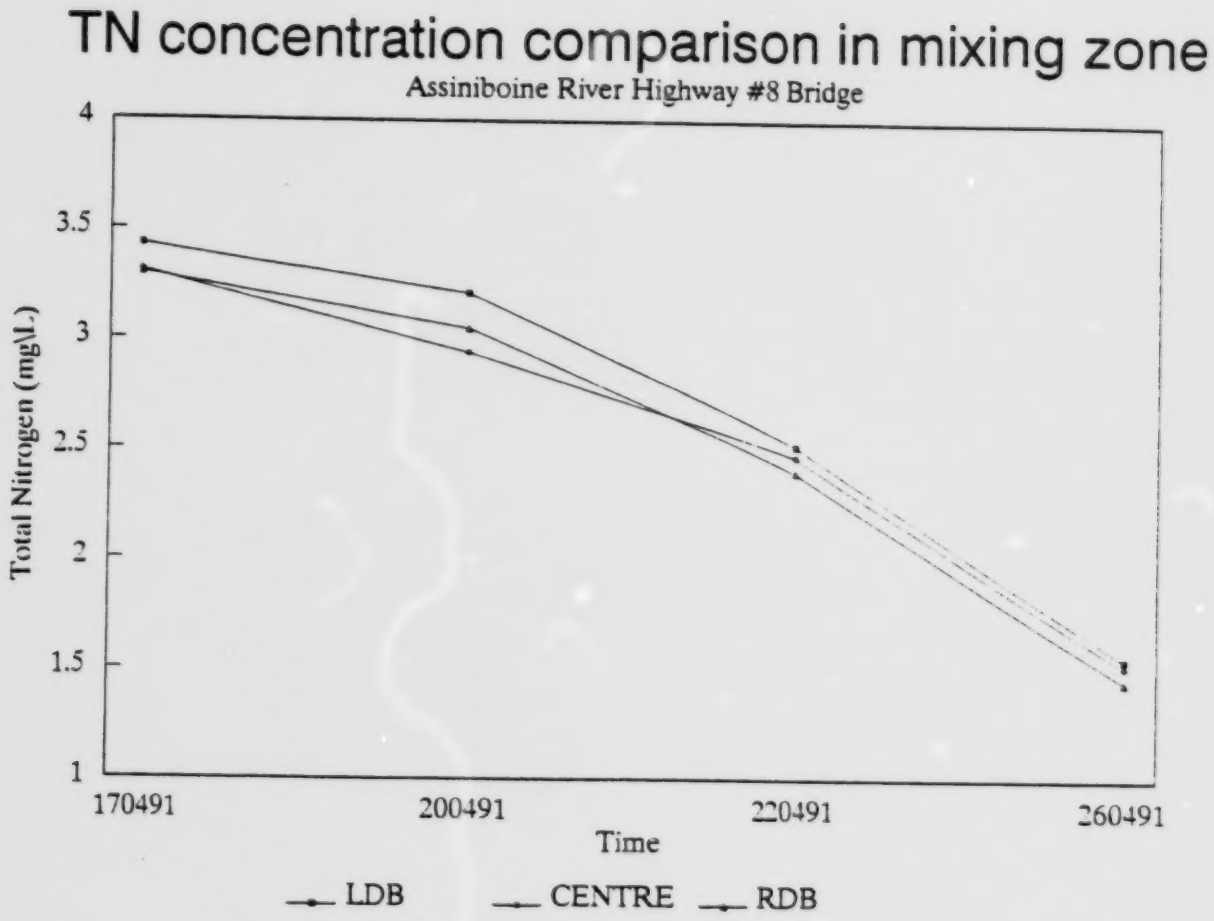


Figure 6: Total Nitrogen (TN) Concentrations Between Leftbank, Centre, and Rightbank Sites at Highway #8 during the Spring Study

* DATA FROM ENVIRONMENT CANADA

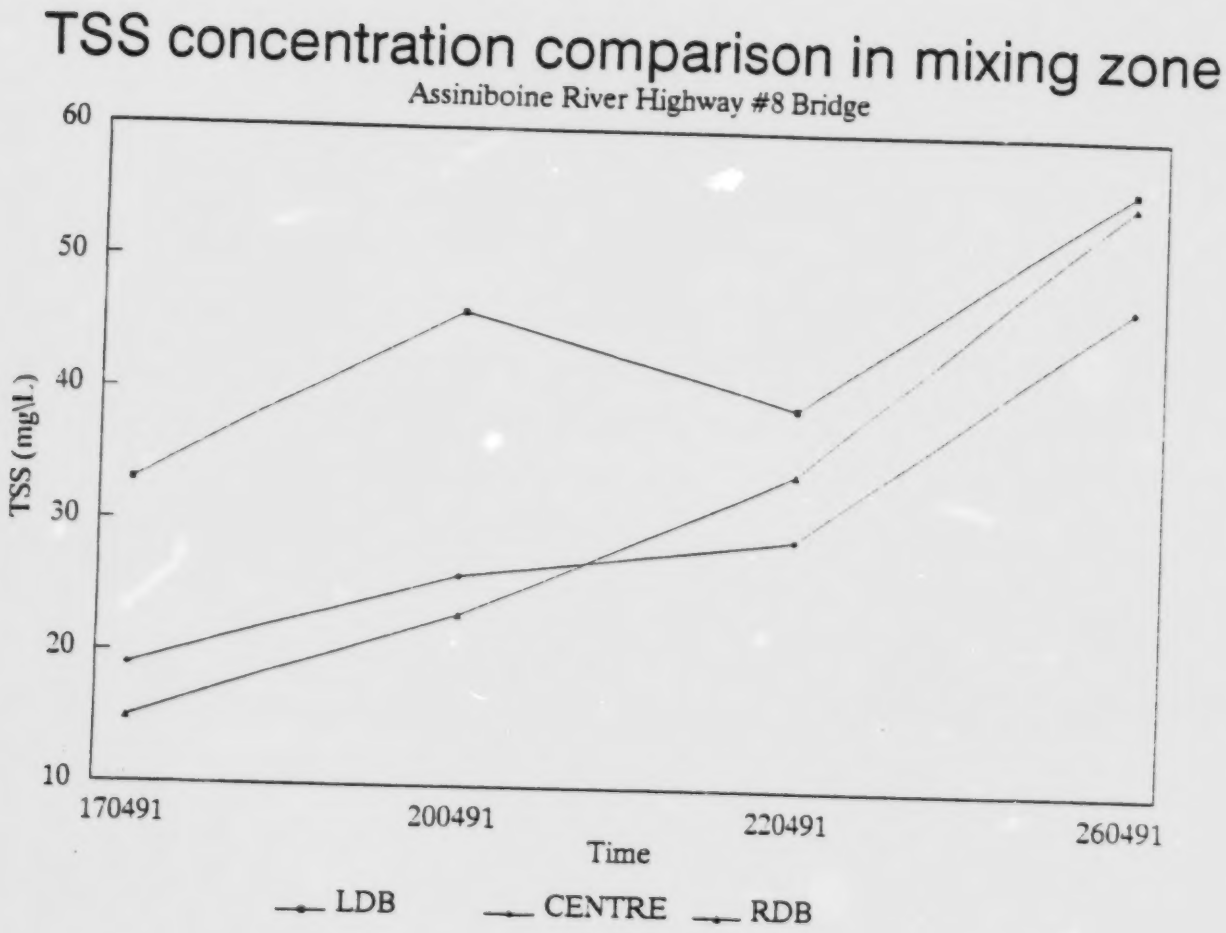


Figure 7: Total Suspended Solids (TSS) Concentrations Between Leftbank, Centre and Rightbank Sites at Highway #8 during the Spring Study

* DATA FROM ENVIRONMENT CANADA

sites were both quite similar (Figure 7). The most statistically significant difference occurred on April 20; TSS at the LDB site (46 mg/L) was 100% higher than the RDB site value (23 mg/L). The differences maybe explained by the sampling methodology used. The samples at these three sites were collected about five or ten minutes apart. As well, the study was not designed to follow a specific "slug" of effluent as it flowed downstream. For the purpose of this study it was determined that the effluent was well mixed by the time it reached the Highway #8 site. Therefore, it was decided that a grab sample from main channel would be representative of the water quality of the river at this site.

It was evident, in particular from the nutrient results, that the water quality at this site was affected by the effluent during the course of this study. The data (Appendix 2), indicated that the nutrient values increased over ambient during the effluent release period. The results of this study confirm the apparent correlation between peaks in TP concentration and the time of effluent discharge in the spring detected in the historical database.

Concentrations of TP at the Highway #357 site was generally lower than those recorded at the Highway #8 site during the effluent discharge period (see Figure 5). The Highway #357 site is closer to the Shellmouth Reservoir, and therefore is probably more representative of the nutrient loading and the water quality entering Manitoba. It is suggested that PPWB investigate moving their Highway #8 site to Highway #357 or investigate some other alternatives.

5.1.4 THE WATER QUALITY OF THE SPRING SEWAGE EFFLUENT

The Town of Kamsack's two effluent lagoons are regulated by SEPS Sewage Work Design Guidelines (1989) and meet the guidelines established for storage capacity and biochemical oxygen demand (BOD) loading in aerobic lagoons. The water quality of the final effluent was analyzed and the raw data is presented in Appendix 2. Appendix 5 shows graphically the changes to some of the parameters over time. During the period of study, the effluent was initially of poor quality with elevated concentrations of TSS, TDS, BOD, DOC, TKN, sulphate, ammonia, sodium and chloride ions, conductivity, and bacteriological counts. The concentrations of these parameters peaked and remained at high levels until around April 22. The concentrations of these parameters decreased and remained at lower levels until the last sampling date (April 27) when they began to increase (see Figure 8).

The poor quality of the effluent in early spring may result due to a reduction of decomposition processes during the winter months when temperatures are cold. For more information on these processes see Klein (1962).

5.2 THE FALL MONITORING PROGRAM

The Town of Kamsack's 1991 effluent release started on October 21 and ended on October 29. This timing was in accordance with the

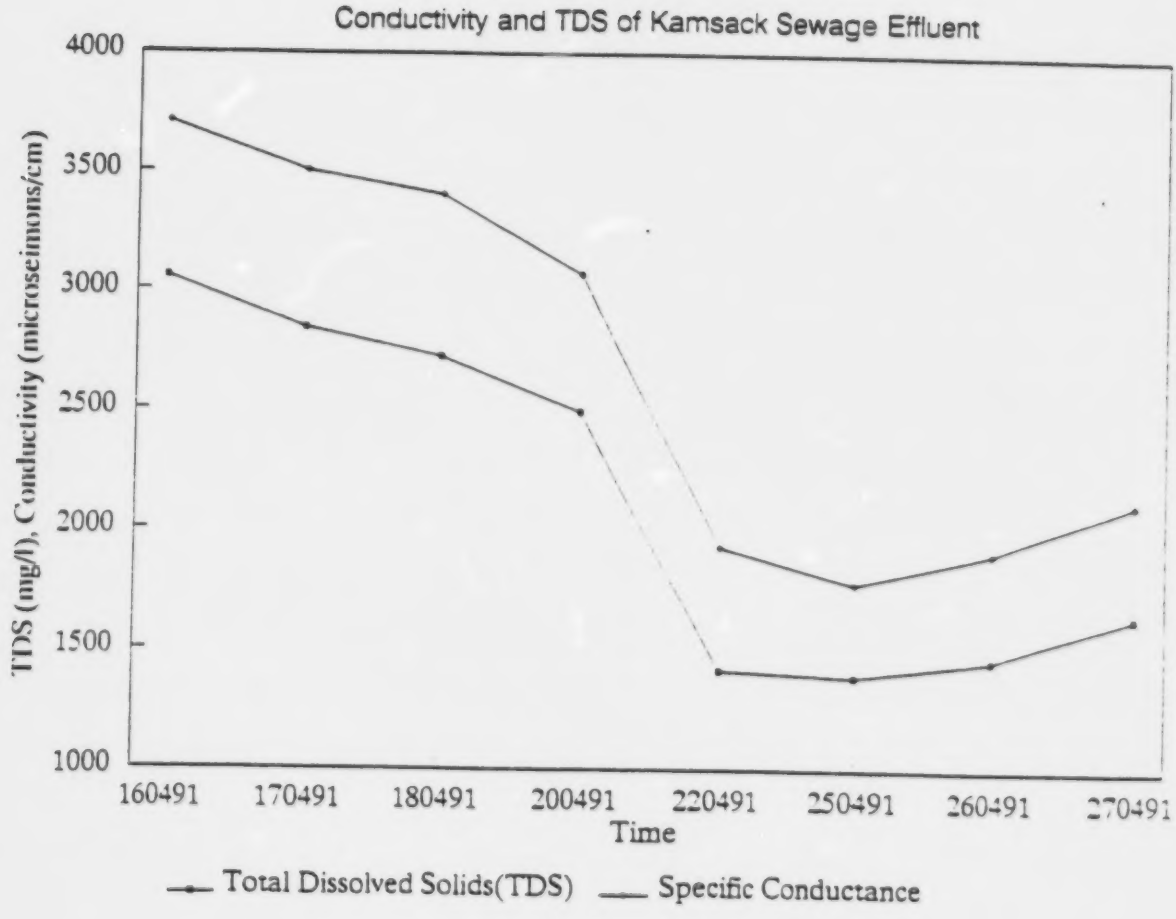


Figure 8: Conductivity and Total Dissolved Solids (TDS) of the Spring Final Sewage Effluent

* DATA FROM SEPS PROVINCIAL LAB

SEPS permit. An estimated volume of 13.25 million imperial gallons (61,875,000 litres) of effluent was released into the Assiniboine River (Dave Clark personal communication). This was approximately one half the volume of the spring release. The average rate of flow was calculated to be 0.012 m^3/s. The average rate of flow in the river during the release was 0.02 m^3/s (Table 4). Therefore, the fall effluent release was responsible for 60% of the flow in the river. As a result of the low flow conditions during the sampling period, only partial conclusions can be drawn from the data in regards to the nutrient loading and the overall impact of the effluent on the Assiniboine River and Shellmouth Reservoir.

5.2.1 IMPACT OF THE FALL EFFLUENT ON THE ASSINIBOINE RIVER IN RELATION TO SEPS SURFACE WATER QUALITY OBJECTIVES

As mentioned, the river flows were negligible during the fall 1991 release period. No indication of any impact was evident in the data until after the discharge had ended. On November 6, exactly one week after the discharge had ended, elevated concentrations in some of the parameters indicative of organic effluent such as nutrients, sulphate, sodium, chloride, total dissolved solids (TDS) and conductivity, were detected at the Highway #8 site (Appendix 6 & 7). No parameters exceeded SEPS surface water quality objectives (1988). However, the water quality remained satisfactory for

livestock watering.

Therefore, during the fall of 1991 good quality effluent was discharged into a river with little flow. The river diluted the effluent and acted much like another settling pond. The diluted effluent probably improved in quality as it moved slowly downstream, towards Shellmouth Reservoir. The effluents' impact on the river was considered minimal.

5.2.2 NUTRIENT LOADING RESULTING FROM THE FALL EFFLUENT RELEASE

An estimated 61,875,000 litres of effluent was released into the Assiniboine River during the fall. The average TP concentration of the effluent was 1.66 mg/L (SEPS data). The data was comparable to fall historical data (Appendix 9). An estimated 102.7 kg of phosphorous was released into the Assiniboine River. This was about one tenth of the amount of TP loading that occurred during the spring release.

During fall program the average flow in the Assiniboine River was 0.064 m^3/s (Table 4). Using EC data, the average TP concentration was 0.180 mg/L and 0.091 mg/L at Highway #8 and Highway #357 sites respectively (Appendix 6). The total daily phosphorous loadings calculated for the Highway #8 site was 0.994 kg/day, and for the Highway #357 site 0.501 kg/day (Table 6). The fall data showed that the phosphorous loading was higher using Highway #8 data. This may have been because of the high TP value

recorded on November 5 of 0.373 mg/L. This high value indicated that the effluent "plume" had reached the Highway #8 site.

The data collected during the fall program cannot be used to provide an accurate estimate of TP loading. Only one site (Highway #8), on one sampling date (November 5), was affected by the effluent discharge when the river was not flowing. The data does suggest that the TP loading during the fall release would be at most a tenth of the spring loading. It was more likely to be less because of the river's capacity to assimilate nutrients via the sediment, flora and fauna, etc.

In summary, the combination of low river flow and a lesser volume of good quality effluent discharged into the Assiniboine River resulted in a TP loading that was one tenth, or less, of the spring loading.

5.2.3 EFFECTS OF FALL DISCHARGE ON PPWB'S HIGHWAY #8 MONITORING SITE

The Highway #8 site was affected by the effluent. The impact occurred approximately one week after the effluent discharge had ended and resulted in elevated concentrations of parameters usually affected by organic effluent. Since the fall program was not designed to sample a receiving river which had no flow, the affect, if any, of the effluent on both the Highway #8 site and the Highway #357 site, cannot be fully understood.

The data does indicate that a sample collected by PPWB at the

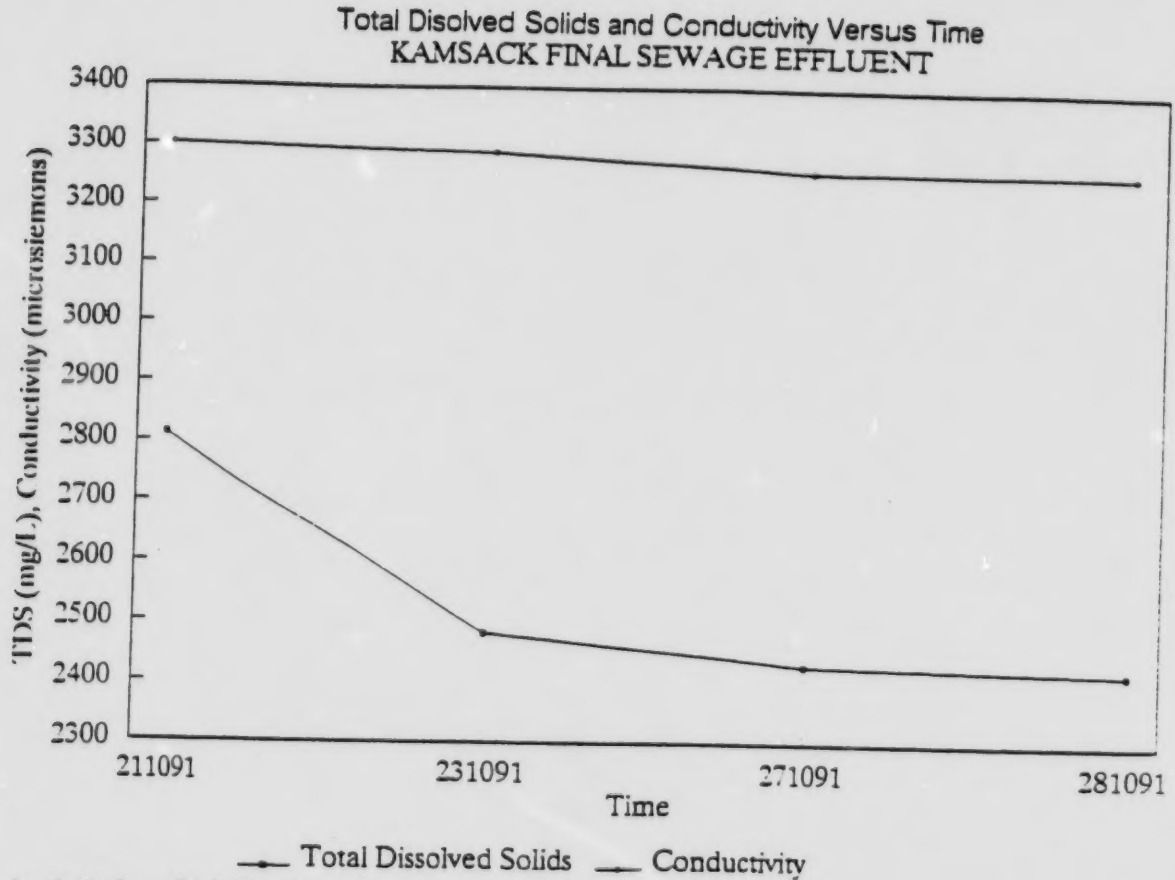
Highway #8 site during the fall release, could be affected depending on the flows and the time the sample was collected. This could explain the "sporadic" TP peaks seen during the fall in PPWB's data over the last 20 years (Figure 2).

It is suggested that the PPWB and any other organization sampling the Assiniboine River, be made aware of the timing of the Kamsack effluent discharges and the fact that the river may not be flowing year round. All sampling programs should be designed to insure that water samples are not coolected during effluent discharges or during times of no flow. It is also suggested that a review of all existing data collected at the Highway #8 site, be undertaken to insure its validity particularly for use with respect to nutrient modelling.

5.2.4 THE WATER QUALITY OF THE FALL EFFLUENT

The final effluent data from the fall monitoring program is presented in Appendix 6 and graphically in Appendix 8. The fall effluent was considered to be consistent and of very good quality. It met all SEPS effluent quality objectives established in SEPS Guide to Sewage Works Design (1989).

Comparison of the fall and spring effluent data show that many parameters (eg. ammonia, TP, sodium, chloride etc.) had lower concentrations in the fall effluent than in the spring effluent (Appendices 2 and 5 for spring and Appendices 6 and 8 for fall). The effluent quality remained fairly consistent throughout the



Analysis from Sask. Provincial Lab

Figure 9: Conductivity and Total Dissolved Solids (TDS) of the Fall Final Sewage Effluent

entire discharge period (for example see Figure 9). A possible explanation for the better quality effluent could be because the lagoon bacteria decompose sewage sludge or organic matter more efficiently during the summer when temperatures are high. A more in-depth discussion of these processes is not within the scope of this report. See Klein, (1962) for more information on these processes. This information does suggest that if the spring discharges were to be delayed, warmer temperatures could be utilized to help improve the effluent quality, and the effluent impact could be further reduced, particularily woth respect to nutrient levels. Other jurisdictions such as Alberta, have increased the holding capacity of their lagoons so that release can occur after optimum treatment. If adequate assimilation flows are still available after such treatment, it is recommended that SEPS investigate this idea further on a site by site basis.

6.0 CONCLUSIONS

In conclusion, monitoring of the Town of Kamsack's effluent discharges into the Assiniboine River, produced data which suggested that the overall impact of the effluent on the river was minimal. Elevated levels were recorded for a few water quality parameters. Exceedences of ammonia levels were recorded in the spring. Nutrients such as phosphorous and nitrogen, showed elevated values during both release periods. In the spring, concentrations of the parameters returned to ambient levels at both affected

downstream sites within six days after the end of the release. Due to very low flows in the Assiniboine River during the fall study, the effluent plume was not carried to all the downstream sites. SEPS surface water quality objectives (1988) were not exceeded within the effluent plume in the river and therefore, the fall impact was considered minimal.

Data collected from the spring program indicated that the quality of the spring effluent was initially quite poor. It improved after a few days but then got poorer again near the end of the release period. In spite of very high bacteriological counts in the spring effluent, the low counts observed in the river downstream of the discharge are difficult to fully explain. The fall effluent was consistantly of good quality.

From the data collected, loading from the effluent, into the Assiniboine River and ultimately into the Shellmouth Reservoir, was estimated. The spring discharge added approximately ten times more phosphorous to the river than the fall discharge (962.8 kg versus 102.7 kg). The TP loading estimated for the two Assiniboine River sites downstream of the discharge (Highway #8 and Highway #357) demonstrated that both sites had a much higher TP loading during the spring release period than during the fall. Using only the spring data, it was demonstrated that the daily TP loading was higher when the effluent was being released than when it was not.

In 1991, a below normal flow year, approximately 66% of the phosphorous loading at the Highway #8 site comes during the rest of the year and during the spring runoff and not as a result of the

effluent releases. The yearly loadings are highly variable with river flows. Highway #8 daily TP loadings were higher than Highway #357 daily loadings regardless of the time of year. The significance of the effluent nutrient addition (although not having apparent impacts on the river) to Shellmouth reservoir remains to be determined by studies currently being undertaken by Manitoba.

The data collected also indicated that the Highway #8 site, which the PPWB uses, was influenced by the effluent releases and that the effluent was quite well mixed by the time it reached this site.

LITERATURE CITED

Blackwell, Ron. Saskatchewan Water Corporation. Personal Communication.

Clark, Dave. Town of Kamsack. Personal Communication.

Dunn, G. Prairie Provinces Water Board. Personal Communication.

Klein L. 1962. River Pollution. Volumes I,II,III

Lane,R.K and Sykes,G.N. 1982. Nature's Lifeline: Prairie and Northern Waters. Canada West Foundation. pp199-205.

Saskatchewan Environment and Public Safety. 1984. Sampling Equipment and Procedures Manual. 141pp.

Saskatchewan Environment and Public Safety. 1988. Surface Water Quality Objectives. WQ 110, 33pp.

Saskatchewan Environment and Public Safety. 1989. A Guide To Sewage Works Design. 52pp.

ACKNOWLEDGEMENTS

The study was co-ordinated and report prepared by Dale R. L. Bonke. Special thanks to the following people who helped complete the study; John Magyar, Dave Clark and the Town of Kamsack staff who cooperated and helped conduct the field sampling; Karl Lauten, Bob Ruggles, Kim Hallard and Sara Pritchard for their review comments on preparing the final report; Also special thanks to Sharon Gurney, Paul Niel and Barney Kenney for helping to intiate the study.

Also, thanks to PPWB for covering part of the analytical costs of this study.

LIST OF APPENDICES

Appendix 1	Photographs of Sampling Sites
Appendix 2	Data From the Spring Program used in this Report
Appendix 3	Concentration versus Time Graphs of the Spring Data for Sites on the Assiniboine River
Appendix 4	Concentration versus Time Graphs of Spring Data collected at Highway #8 Leftbank, Rightbank and Centre Sites
Appendix 5	Concentration versus Time graphs of the Final Spring Sewage Effluent
Appendix 6	Data From the Fall program used in this Report
Appendix 7	Concentration versus Time Graphs of the Fall Data for Sites on the Assiniboine River
Appendix 8	Concentration versus Time graphs of the Final Fall Sewage Effluent
Appendix 9	Historical Kamsack Sewage Effluent Data Featuring Total Phosphorous

APPENDIX 1

PHOTOGRAPHS OF STUDY AREA

SAMPLING SITES

The following is a brief description of each photograph:

* Photographs #1-2, show the Assiniboine River at the Highway #5 bridge site (Site 1). This is the upstream site.

* Photographs #3-4, show the Assiniboine River at Highway #8 Bridge site (Site 2). This is approximately three river kilometres downstream of the sewage release area.

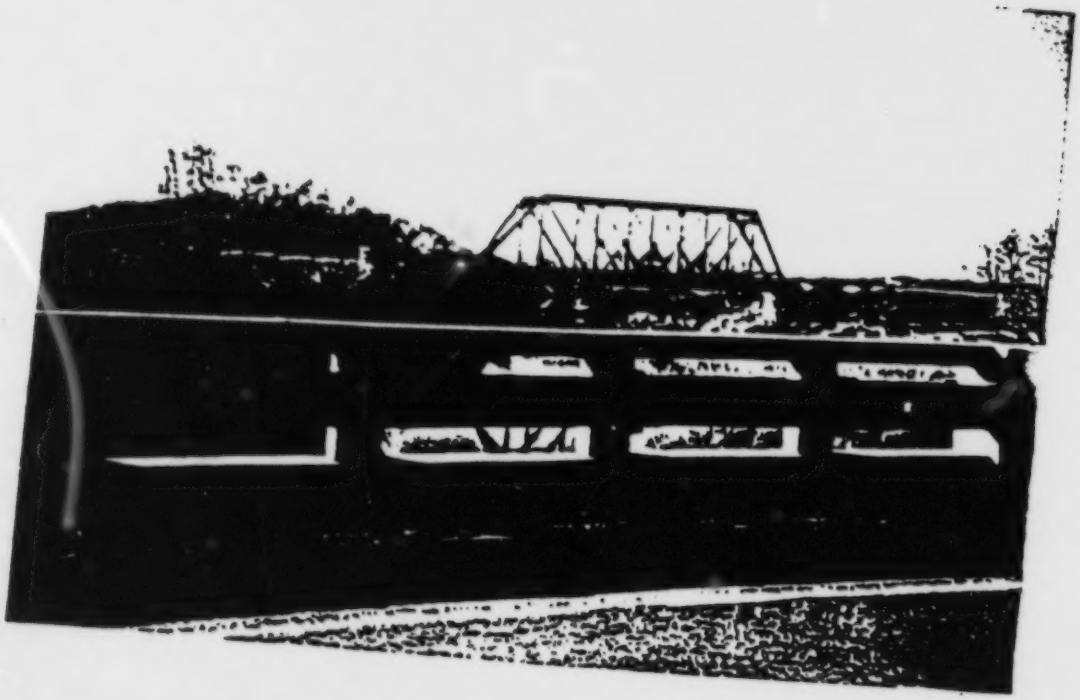
* Photographs #5-6 shows the Assiniboine River at Highway 357 Bridge site (Site 3). This site is the furthest downstream site just before the Shellmouth Reservoir.

* Photographs #7-8 shows the site where the Kamsack sewage effluent enters the Assiniboine River (Site 4). This is where the effluent samples were collected.

* Photographs #9-10 show the Kamsack sewage lagoons.

* Photographs #11-12 show the Shellmouth Dam and Spillway.

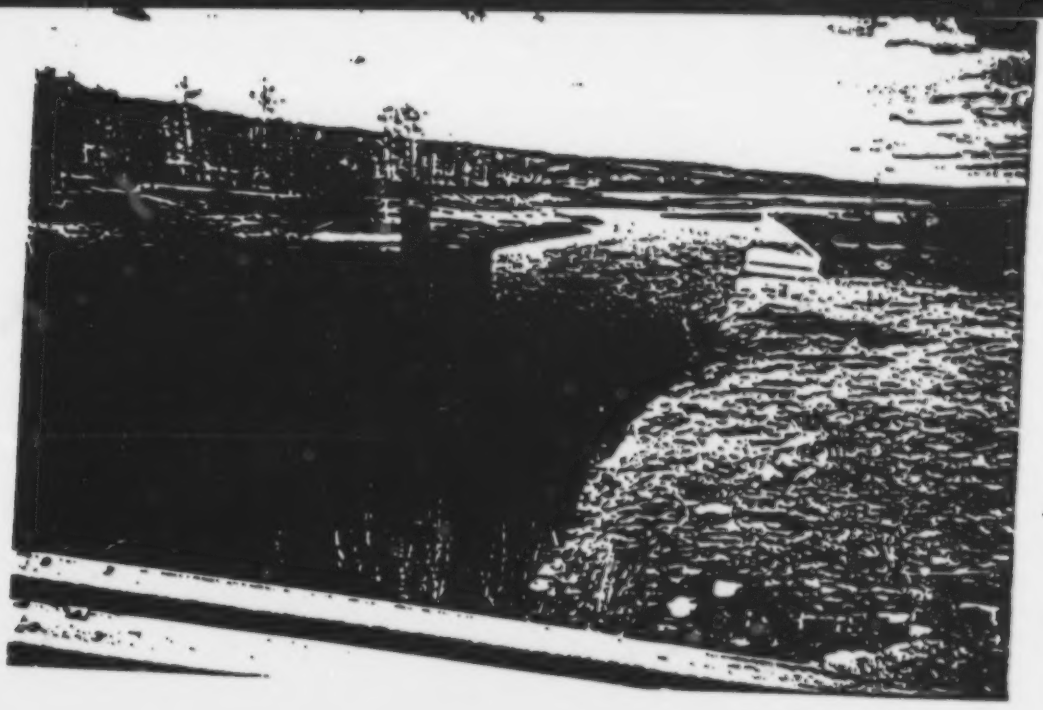
1.



2.

3.

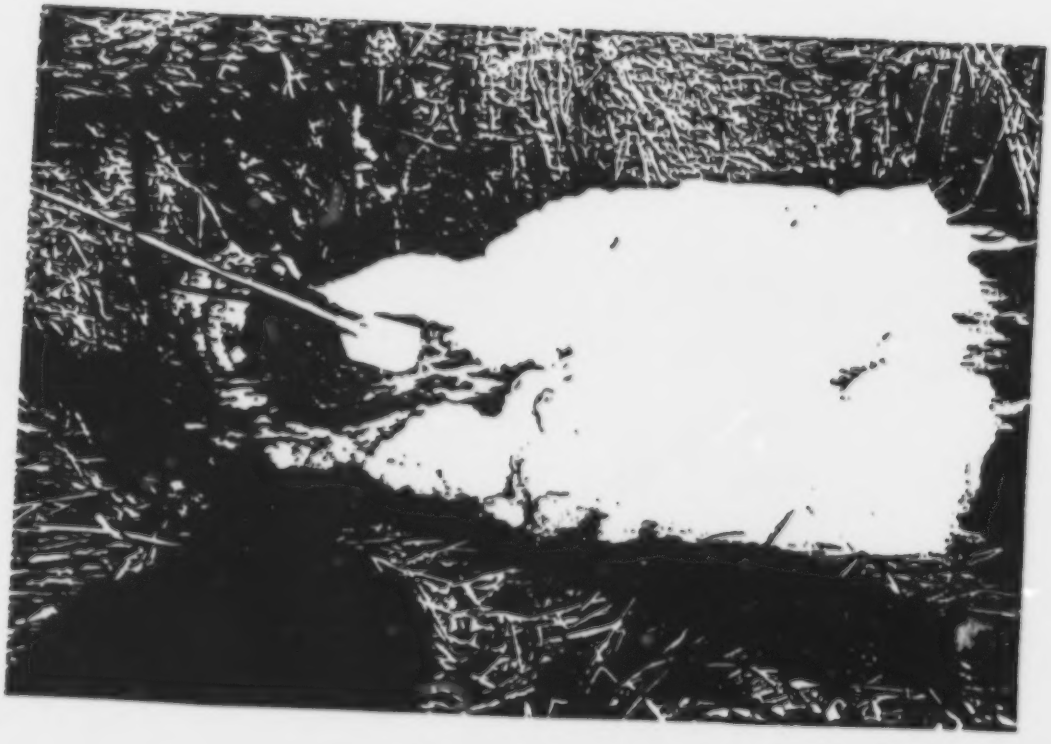
4.



5.

6.

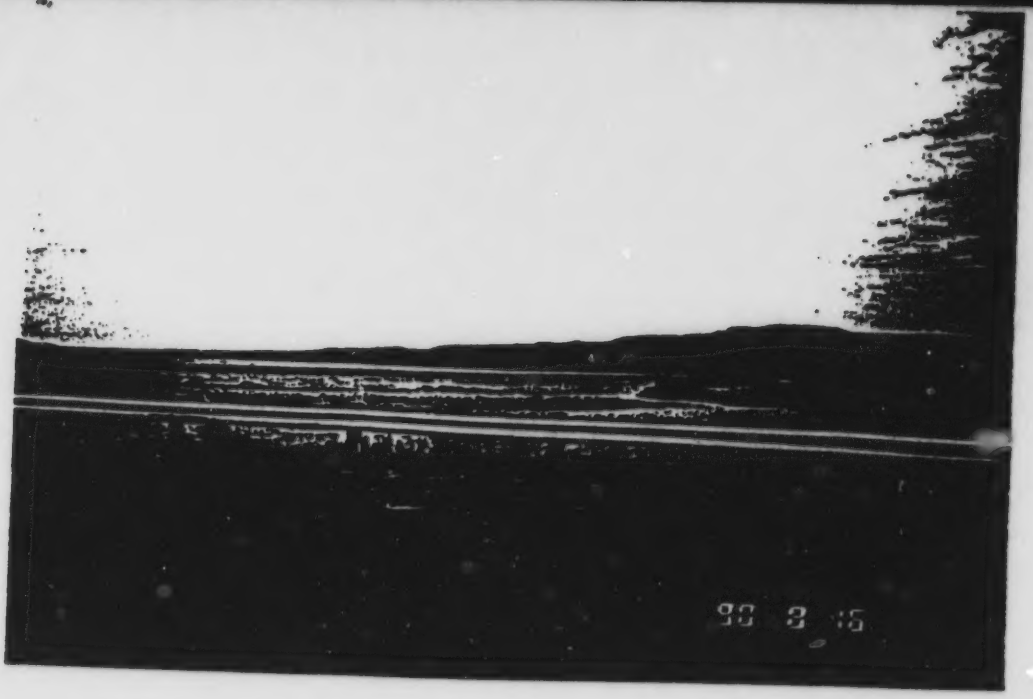
7.



8.

9.

10.



11.

12.

APPENDIX 2

THE SPRING MONITORING PROGRAM DATA

Site: Kansack Sewage Lagoon Final Effluent

Parameter and or as specified	Parameter Codes	Dates Samples Collected 170491	200491	220491	260491	250491	270491	160491	180491	Lab
D.O.	08101W	2	3.4	3.2	2.7					E
TEMP. Deg. Cel.	02061P	2	3	5	11					P
AMMONIA	07540P	39.2	37.7	18.3	15.4					P
DOC	06104L	54	47	25.1	24.7					P
TN	07603L	34.23	29.69	15.92	11.12					P
TP	15423L	9.41	8.84	6.26	6.64					P
SULPHATE	16308L	710	680	380	315	320	320	690	700	P
CHLORIDE	17204L	412	372	212	201	200	218	453	405	P
SODIUM	11102L	430	378	214	205	196	235	455	425	P
TDS	00206L	2839	2494	1415	1462	1391	1646	3056	2722	P
SPEC. COND. micros	02041L	3500	3070	1930	1910	1780	2120	3710	3400	P
BOD	08202L	90	93	56	21	26	56	378 X		P
TKN	07016L	52.3	47.5	27.3	25.3	18.6	21	43.5	45.6	P
AMMONIA	07506L	32.75	27.4	14.49 W	W		14.35	8 W		P
TP	15409L	10.21	10.5	6.25	6.75	5.5	7	10.5	9.4	P
TSS	10406L	14	29	27	16	24	76	36	16	P
TC	36002L	43000	240000	43000 W		43000	15000	23000	23000	P
FC	36012L	43000	93000	23000 W		Q1500	9300	23000	23000	P
DOC	06117L	84.1	73.8	43.4	24	38	28	79.9	87.5	P
CA	20100L	165	154	93	80	232	109	179	162	P
MG	12101L	146	122	81	85	122	91	160	127	P

E - Environment Canada
P - SEPS

Site: Assiniboine River at Highway #5 Bridge (Site 1).

Parameter and/or as specified	Parameter Codes	Dates Samples Collected 150491	170491	200491	220491	260491	060591	Lab
D.O.	08101W	11.2	11.6	11.4	15.8	14.2	10.3	
TEMP. Deg. Cel.	02061F	6	6	6	7	10	8	P
AMMONIA	07540P	0.472	0.275	0.024	0.024	0.025	0.028	P
DOC	06104L	11.1	11.5	11.3	12.1	12	12.4	E
TN	07603L	2.06	1.92	1.69	1.34	0.95	0.58	E
TP	15423L	0.252	0.217	0.152	0.173	0.124	0.095	E
SULPHATE	16308L	95	90	96	98	93	126	P
CHLORIDE	17204L	24	32	24	14.3	14.8	20	P
SODIUM	11102L	26	25	22	22	21	30	P
TDS	00206L	411	404	383	385 M		547	P
SPEC. CON Microsie	02041L	511	512	505	504	523	708	P
BOD	08202L	24.0	5.1	6.7	5.9	5.6	2.7	P
TKN	07016L	2.3	1.7	1.7	2.3	2.4	1.2	P
AMMONIA	07506L	0.39	0.2	0.06	0.04 M		0.04	P
TP	15409L	0.28	0.23	0.2	0.2	0.35	0.23	P
TSS	10406L	22	15	25	32	47	14	P
TC	36002L	L10.	L10.	L10.	L2. M		4	P
FC	36012L	L10.	L10.	L10.	L2. M	L2.		P
DOC	06117L	16.1	16.2	14.6	15.5	14	13	P
CA	20100L	44	42	49	49	49	72	P
MG	12101L	27	24	21	25	27	32	P

E - Environment Canada
P - SEPS

Site: Assiniboine River at Highway #357 Bridge (Site 1)

Parameter mg\L or as specified	Parameter Codes	Dates Samples Collected 150491	170491	200491	220491	260491	060591	Lab
D.O.	08101W	10.8	10.4	11.8	16.1	20	10.6	P
TEMP. Deg. Cel.	02061P	4.7	6	8	8	11	7.8	P
AMMONIA	07540P	0.575	0.414	0.96	0.6	0.038	0.027	E
DOC	06104L	10.2	11.1	12.6	12.7	12.1	12.3	E
TN	07603L	2.25	2.06	2.7	2.34	1.56	0.71	E
TP	15423L	0.25	0.244	0.503	0.521	0.413	0.129	E
SULPHATE	16308L	108	108	142	130	149	159	P
CHLORIDE	17204L	28	20	37	36	23.4	15	P
SODIUM	11102L	28	27	43	42	41	30	P
TDS	00206L	425	413	536	513	440	547	P
SPEC. COND. (micro	02041L	538	536	706	673	612	729	P
BOD	08202L	34.2	7	5.4	9	8.4	3.4	P
TKN	07016L	1.9	1.9	2.8	3.7	5.3	1.2	P
AMMONIA	07506L	0.49	0.32	0.59	0.43 W		0.36	P
TP	15409L	0.28	0.24	0.48	0.6	0.35	0.13	P
TSS	10406L	27	19	29	35	98	30	P
FC	36002L	L10.	02400.	L10.	L10 W	L2		P
FC	36012L	L10.	L10.	L10.	L10 W	L2		P
DOC	36117L	15.4	14.5	17	15.3	10	13	P
CA	20100L	46	45	60	55	46	73	P
MG	12101L	24	22	0	32	32	35	P

E - Environment Canada
P - SEPS

Site: Assiniboine River at Highway #8 Bridge,CENTER

Parameter mg\L or as specified	Parameter Codes	Datas Samples Collected 170491	200491	220491	260491	Lab
D.O.	08101W	9.4	11.8	16	12.9	P
TEMP. Deg. Cal.	02061P	6	8	7	11	P
AMMONIA	07540P	1.8	1.56	1	0.575	P
DOC	06104L	13.2	13.4	13.1	12.8	E
TN	07603L	3.31	2.94	2.47	1.52	E
TP	15422L	0.641	0.634	0.549	0.649	E
SULPHATE	16308L	128	129	112	123	P
CHLORIDE	17204L	42	36	33.6	27	P
SODIUM	11102L	43	40	36	36	P
TDS	00206L	504	494	453	478	P
SPEC. COND. micros	02041L	672	646	604	624	P
BOD	08202L	7	6.1	6.9	8	P
TKN	07016L	2.9	3.6	4.1	4.7	P
AMMONIA	07506L	1.65	1.23	0.74 W		P
TP	15409L	0.51	0.65	0.6	0.75	P
TSS	10406L	19	26	29	47	P
FC	16002L	Q19000	80	180 W		P
FC	16012L	590 210		20 W		P
DOC	06112L	18.6	16.7	16.3	13	P
CA	20108L	52	53	50	56	P
MG	12102L	26	28	27	29	P

E - Environment Canada
P - SEPS

Site: Assiniboine River at Highway #8 Bridge,LDB

Parameter mg\L or as specified	Parameter Codes	Dates Samples Collected 150491	170491	200491	220491	260491	060591	Lab
D.O.	08101W	10.3	9.4	11.8	16	12.9	9.6	P
TEMP. Deg. Cel.	02061F	4.7	6	8	7	11	7.8	P
AMMONIA	07540P	0.485	1.86	1.52	1	0.57	0.017	E
DOC	06104L	11.1	13.1	13.2	13	13	12.4	E
TN	07602L	2.2	3.43	3.21	2.52	1.55	0.61	E
TP	15422L	0.265	0.68	0.646	0.58	0.583	0.101	E
SULPHATE	16308L	90	129	129	113	122	130	P
CHLORIDE	17204L	28	43	41	30	30.2	22	P
SODIUM	11102L	26	43	40	36	36	30	P
TDS	00206L	386	505	489	452	466	539	P
SPEC. COND. (micro	02041L	493	673	639	598	611	692	P
BOD	08202L	35.0	Q6.3	7.2	7.6	9.2	2.6	P
TKN	07021L	2.4	3.6	3.4	4.2	4.4	1.3	P
AMMONIA	07506L	0.41	1.65	0.32	0.67 W		0.04	P
TP	15403L	0.29	0.72	0.65	0.65	0.9	0.1	P
TSS	10406L	21	33	46	39	56	16	P
FC	36002L	20	Q2220	150	70 W	L2		P
FC	36012L	L20	560	10	26 W	L2		P
DOC	06117L	15.7	17.9	16.1	17.5	14	13	P
CA	20100L	22	27	25	26	27	35	P
MG	12201L	40	52	58	50	56	67	P

E - Environment Canada
P - SEPS

Site: Assiniboine River at Highway #8 Bridge,RDB

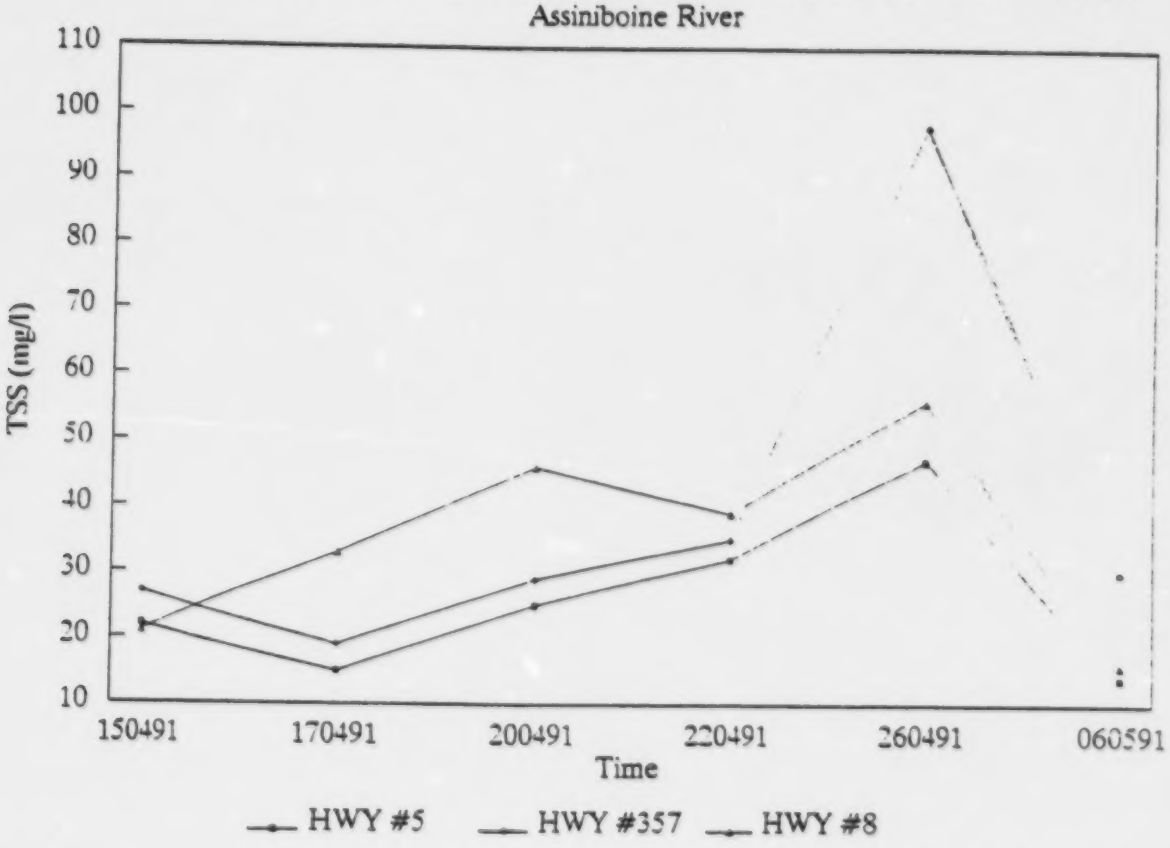
Parameter mg\L or as specified	Parameter Codes	Dates Samples Collected 170491	200491	220491	260491	Lab
D.O.	08101W	9.4	11.8	16	12.9	E
TEMP. Deg. Cel.	020612	6	8	7	11	E
AMMONIA	07540P	1.94	1.5	1	0.55	E
DOC	06104L	13.1	13.1	13.1	12.8	E
TN	07602L	3.3	3.05	2.4	1.45	E
TP	15421L	0.638	0.633	0.565	0.594	E
SULPHATE	16308L	123	120	111	115	P
CHLORIDE	17204L	43	34	29	30.5	P
SODIUM	11102L	43	40	35	36	P
TDS	00206L	518	479	448	455	P
SPEC. COND. micros	02041L	673	646	595	604	P
BOD	08202L	3.8	6.7	6.4	8.4	P
TKN	07016L	3.5	3.4	4.7	4.2	P
AMMONIA	07506L	1.7	1.05	0.8 W		P
TP	15409L	0.62	0.65	0.45	0.75	P
TSS	10406L	15	23	34	55	P
FC	36002L	97000	90	42 W		P
FC	36012L	340 LLO		10 W		P
DOC	06117L	18.4	16.9	16.2	10	P
CA	20100L	50	48	49	55	P
MG	12102L	29	29	27	28	P

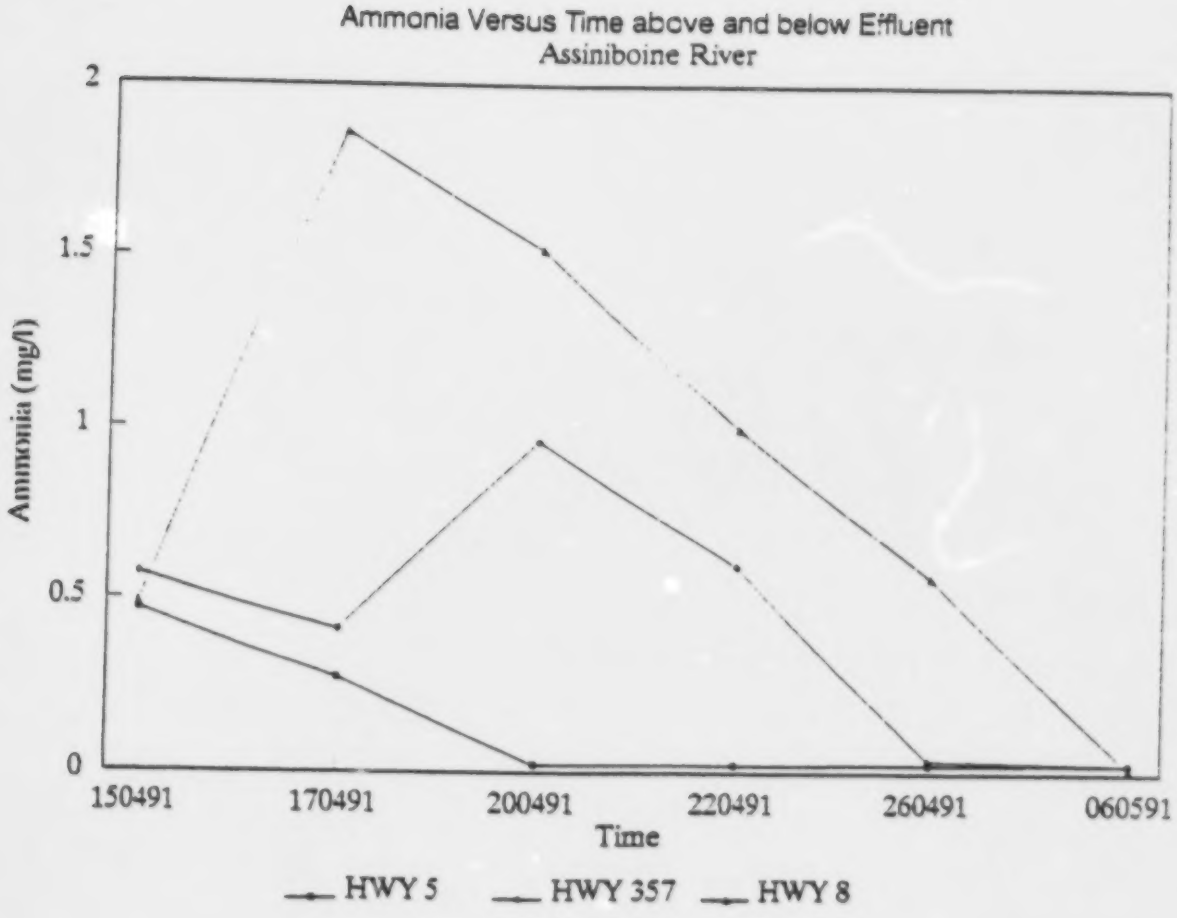
E - Environment Canada
P - SEPS

APPENDIX 3

CONCENTRATION VERSUS TIME GRAPHS OF THE SPRING DATA ON ASSINIBOINE RIVER SITES ABOVE AND BELOW THE KAMSACK SEWAGE RELEASES.

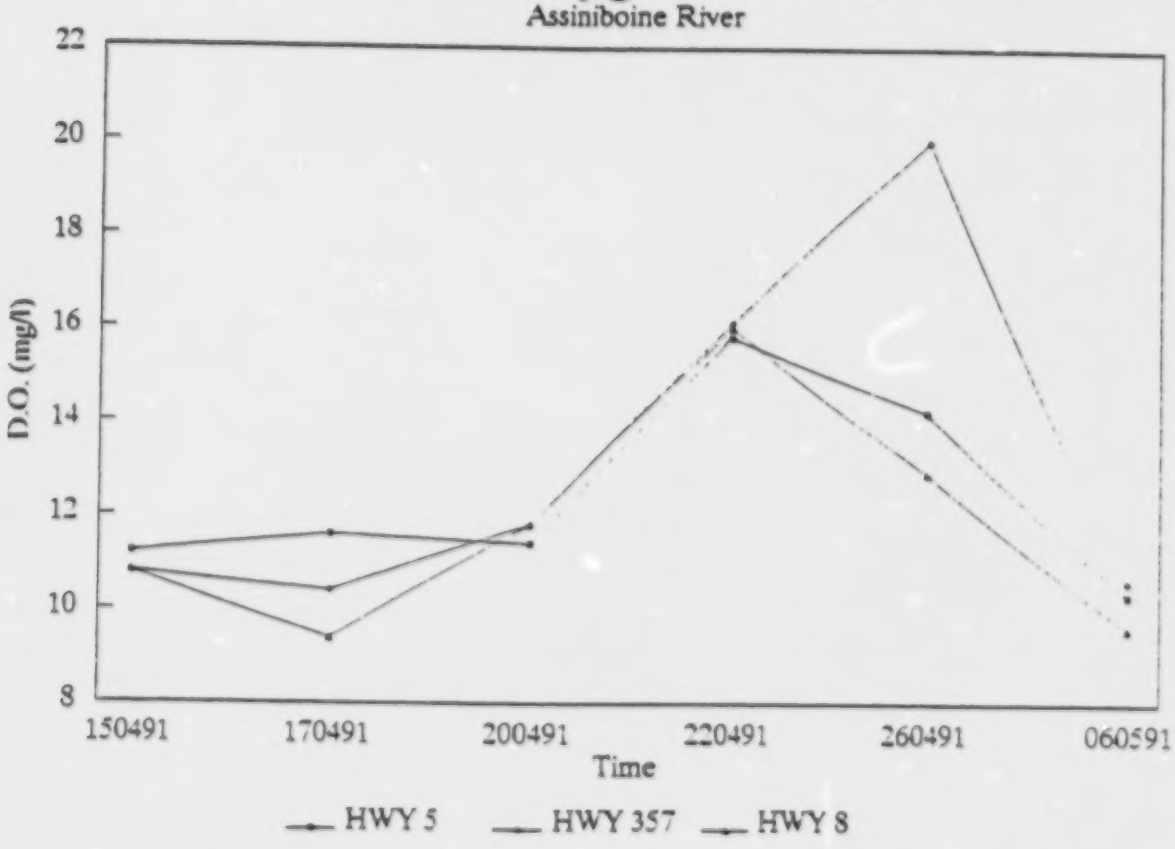
TSS vs Time above and below Effluent



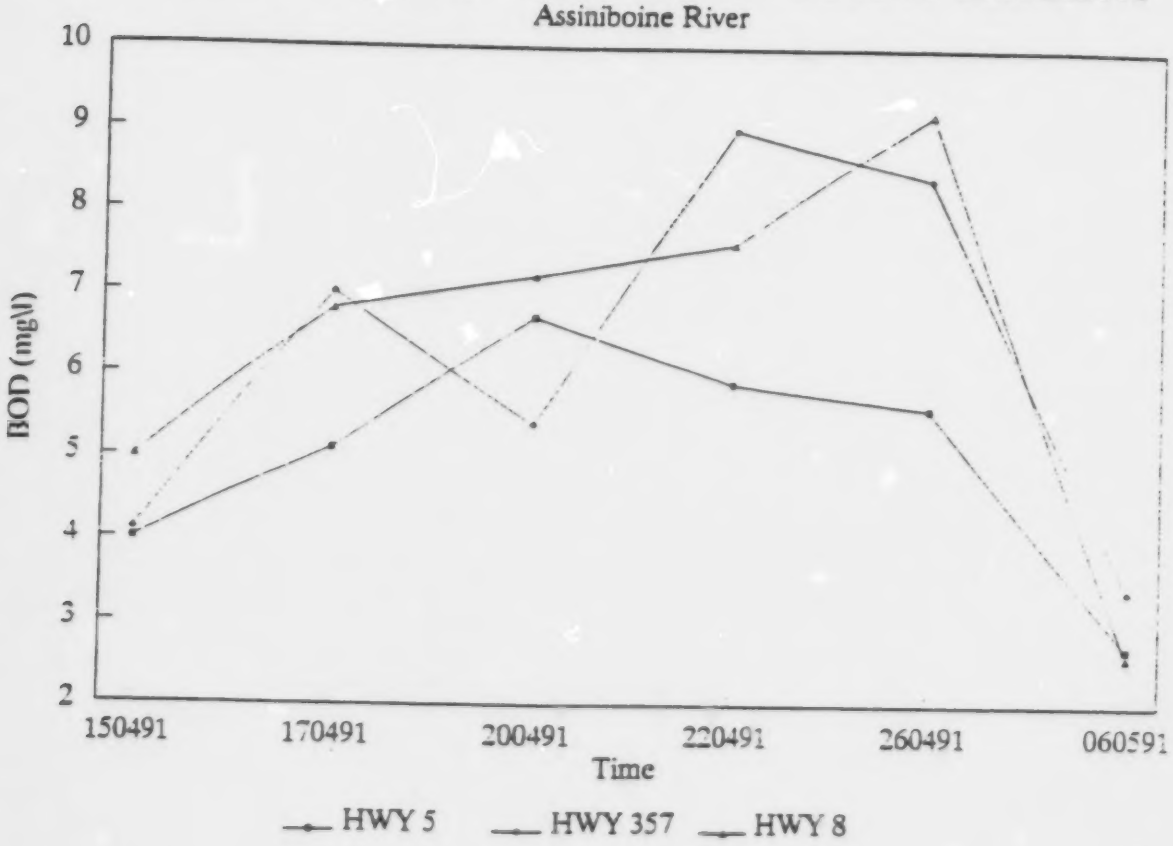

Ammonia Versus Time above and below Effluent
Assiniboine River
2
1.5
1
0.5
0
Ammonia (mg/l)
150491
170491
200491
220491
260491
060591
Time
HWY 5
HWY 357
HWY 8

Dissolved Oxygen Versus Time

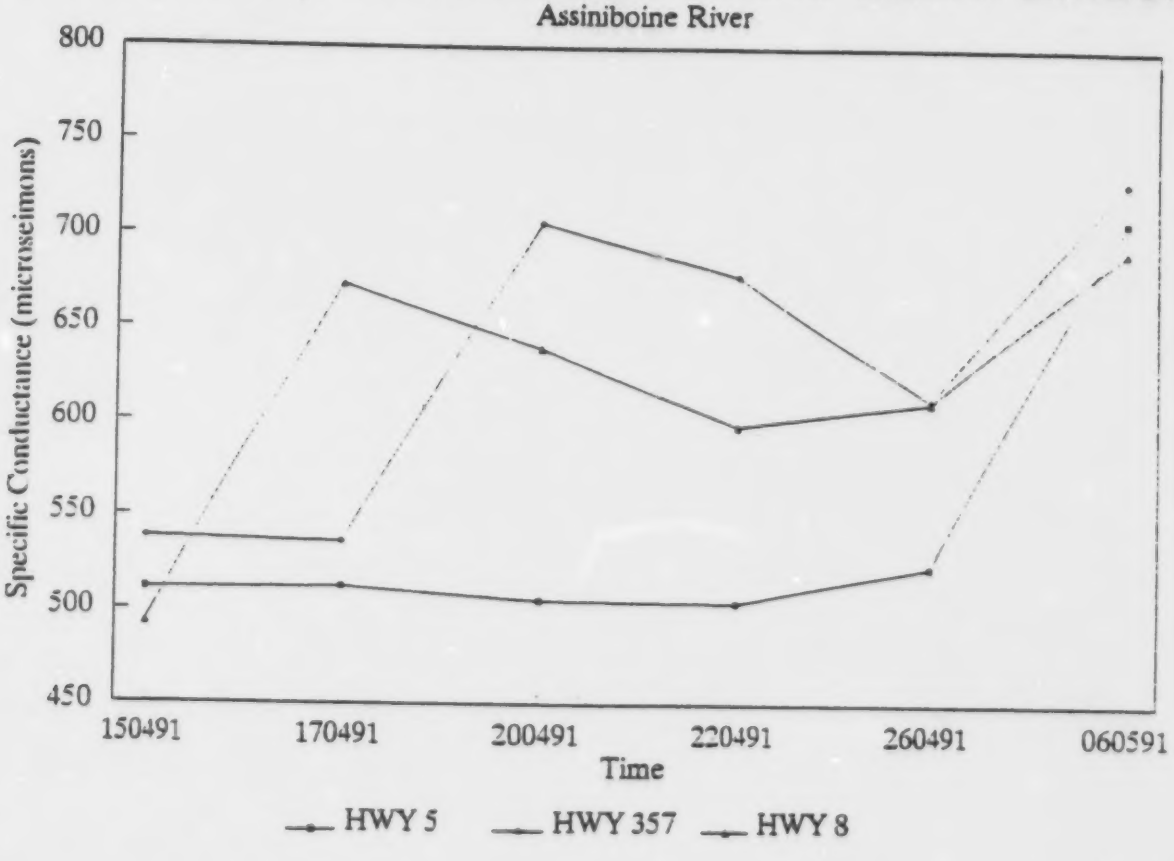
Assiniboine River



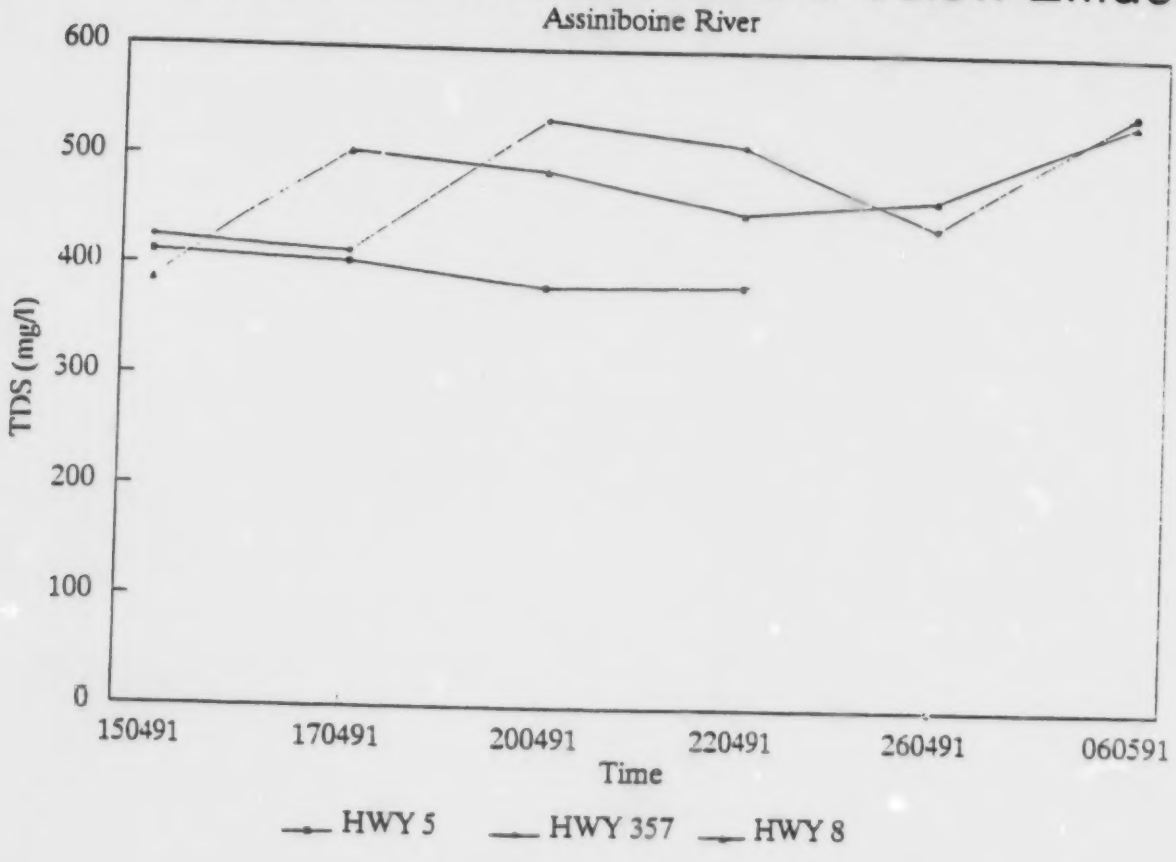
BOD VS Time above and below Effluent

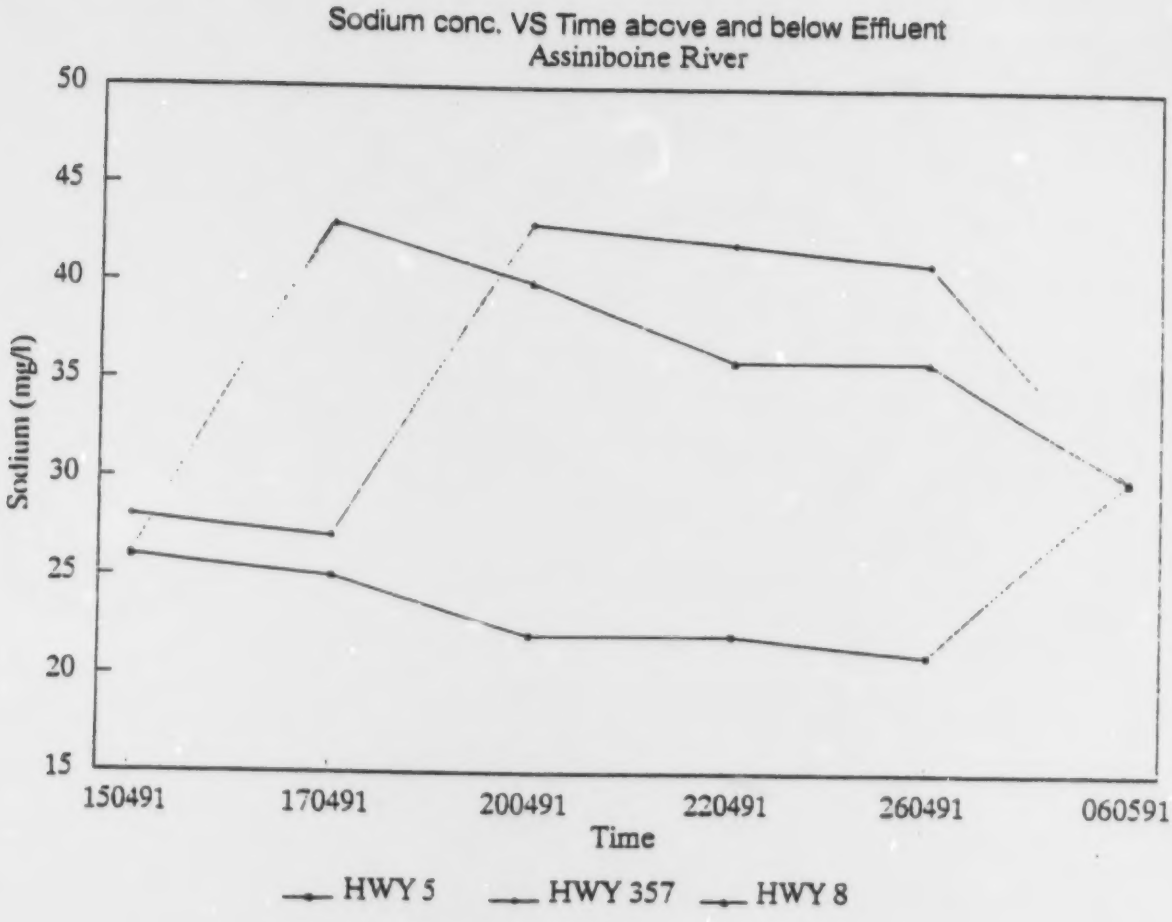


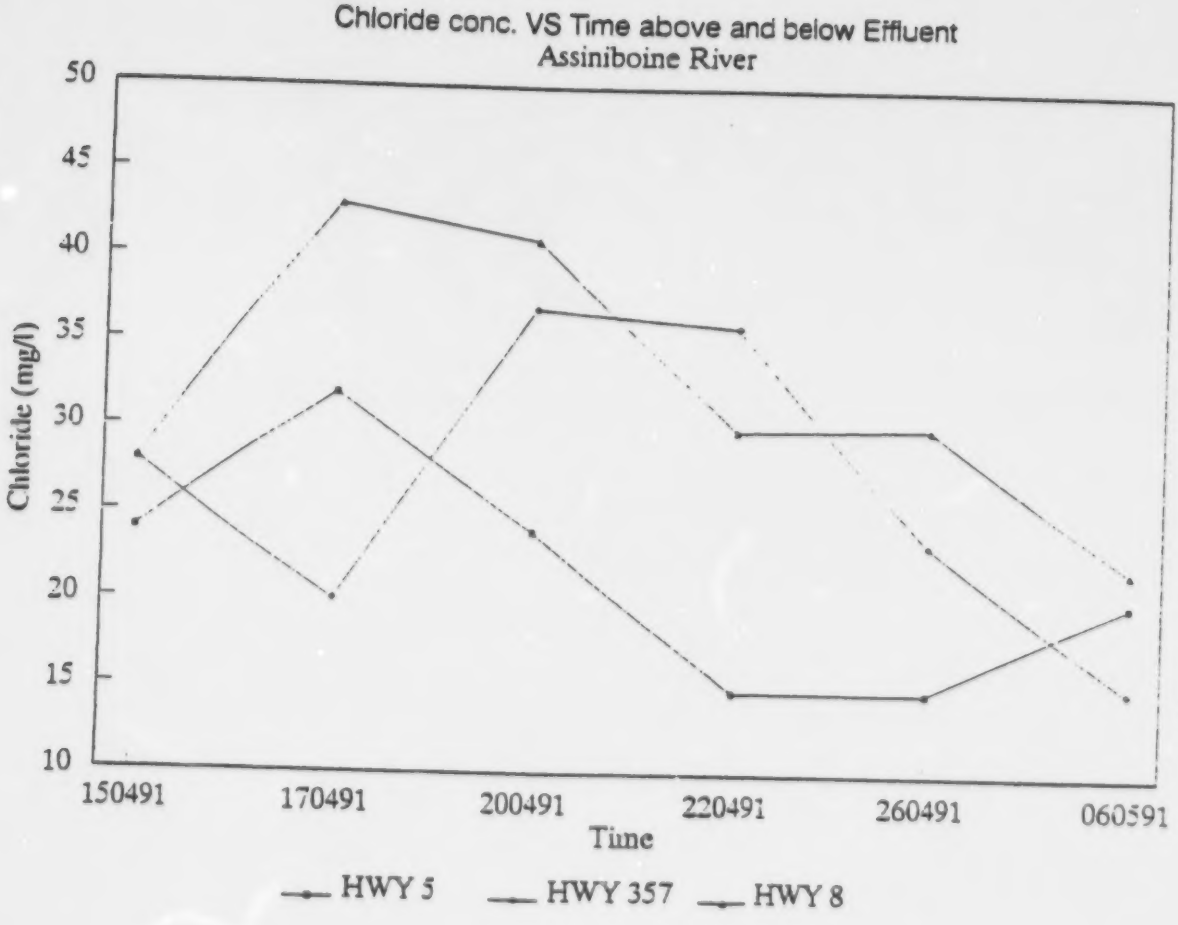
Conductivity VS Time above and below Effluent



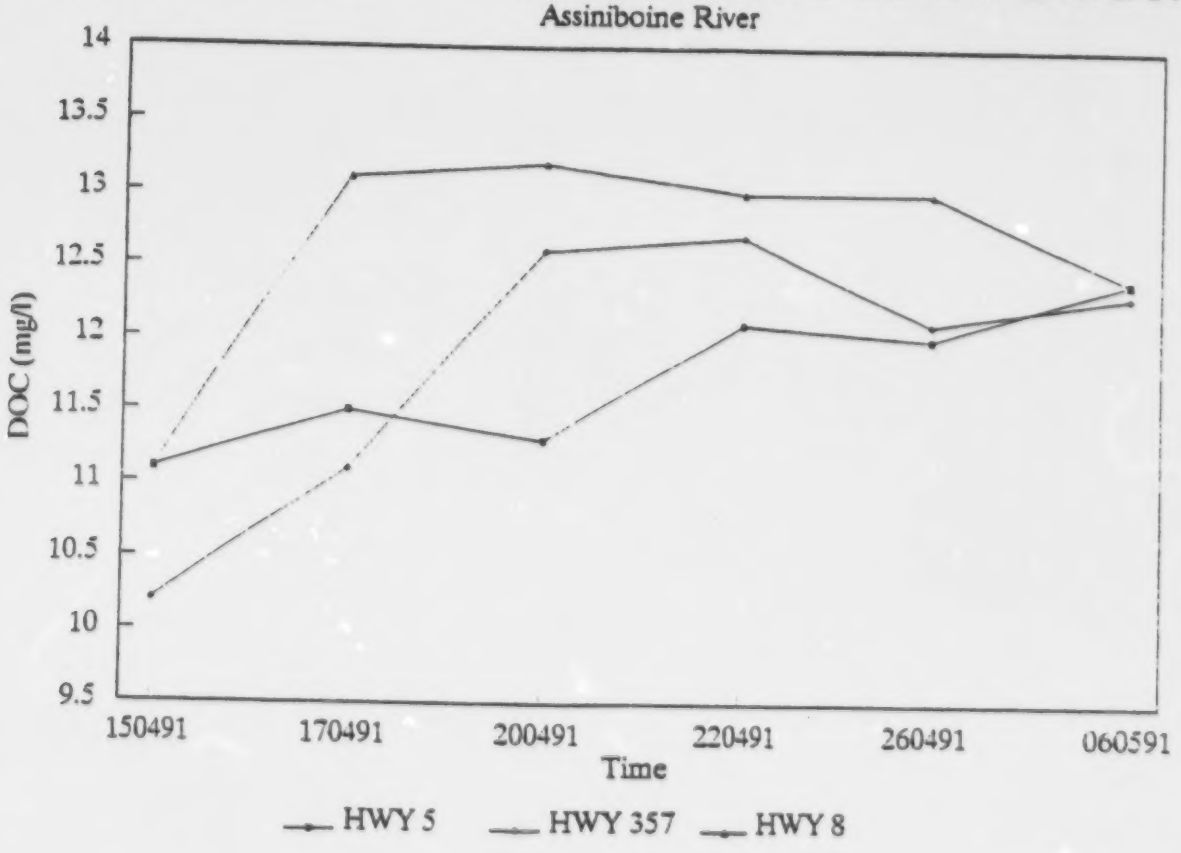
TDS conc. VS Time above and below Effluent

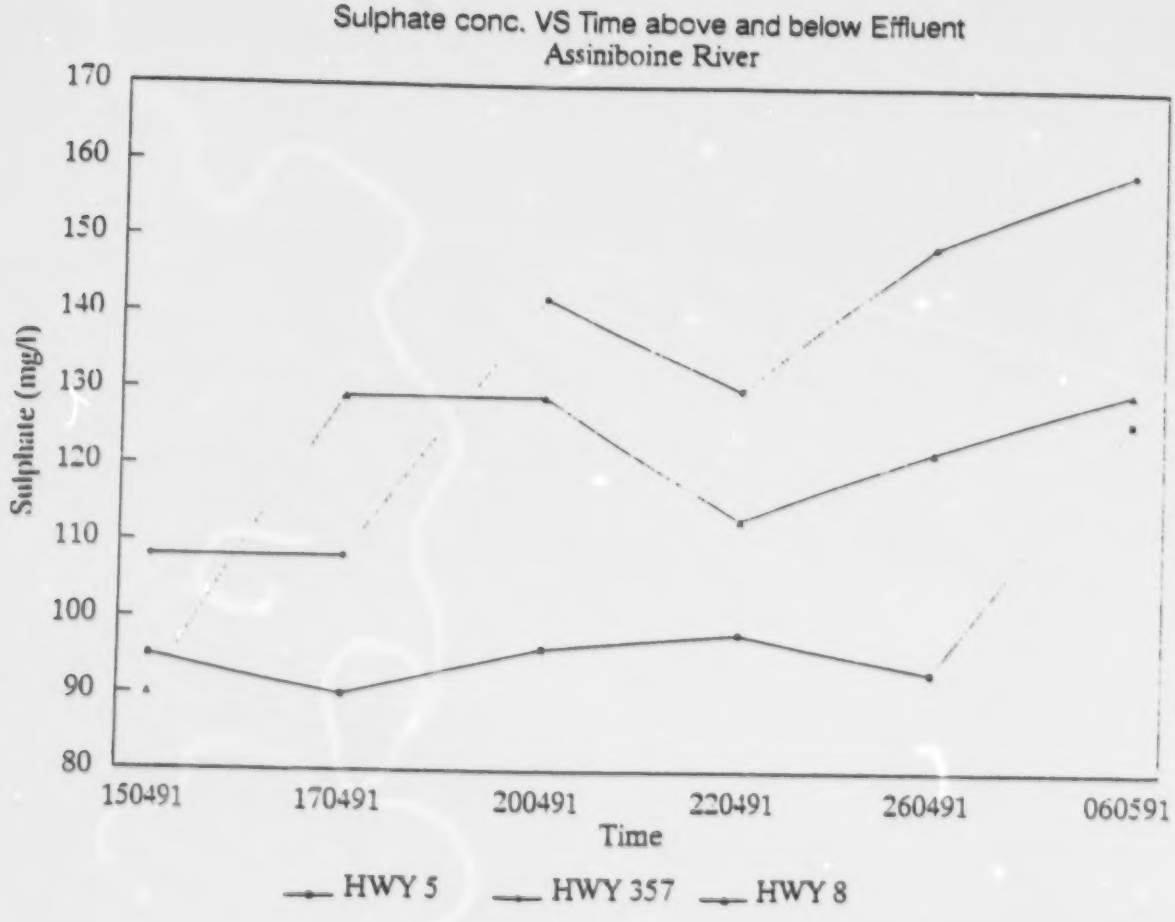


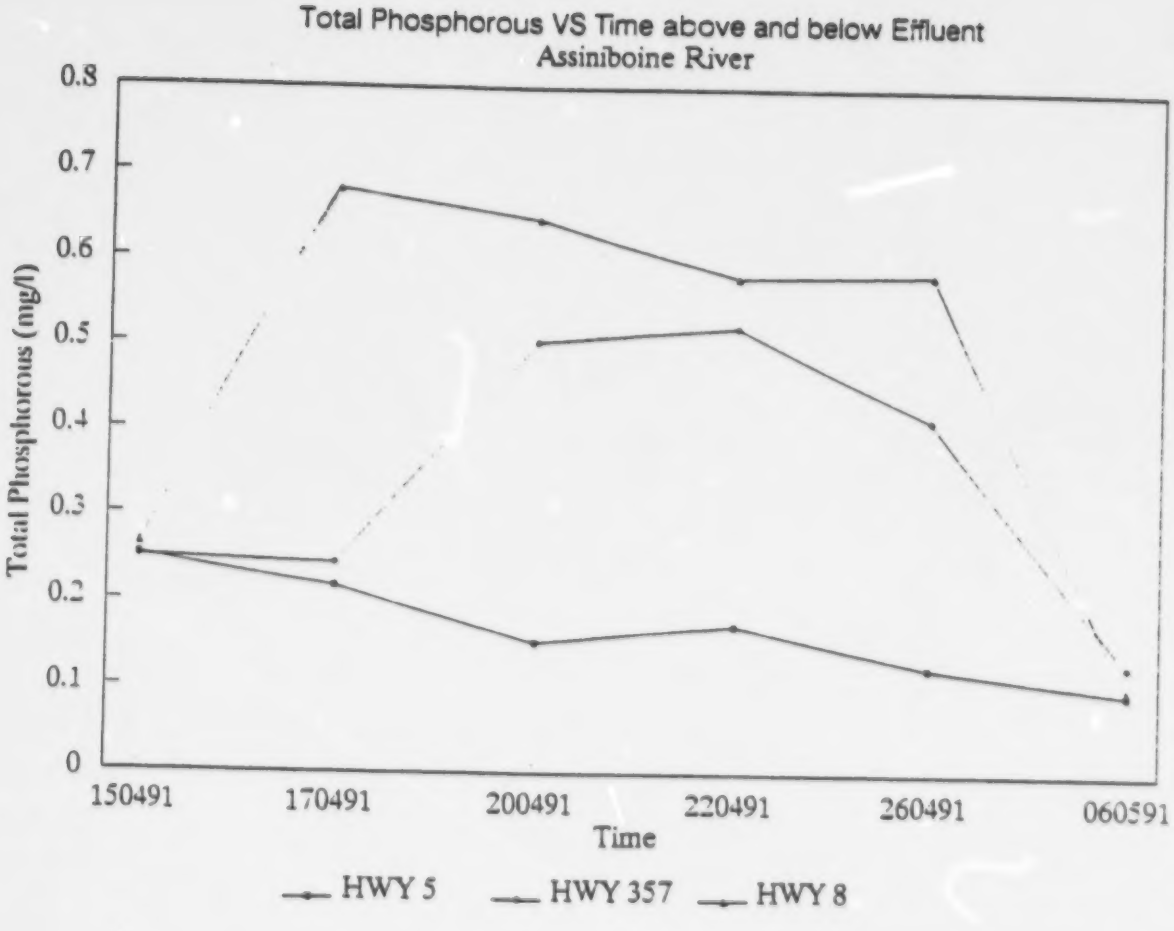

Sodium conc. VS Time above and below Effluent
Assiniboine River
50
45
40
35
30
25
20
15
Sodium (mg/l)
150491
170491
200491
220491
260491
060591
Time
HWY 5
HWY 357
HWY 8

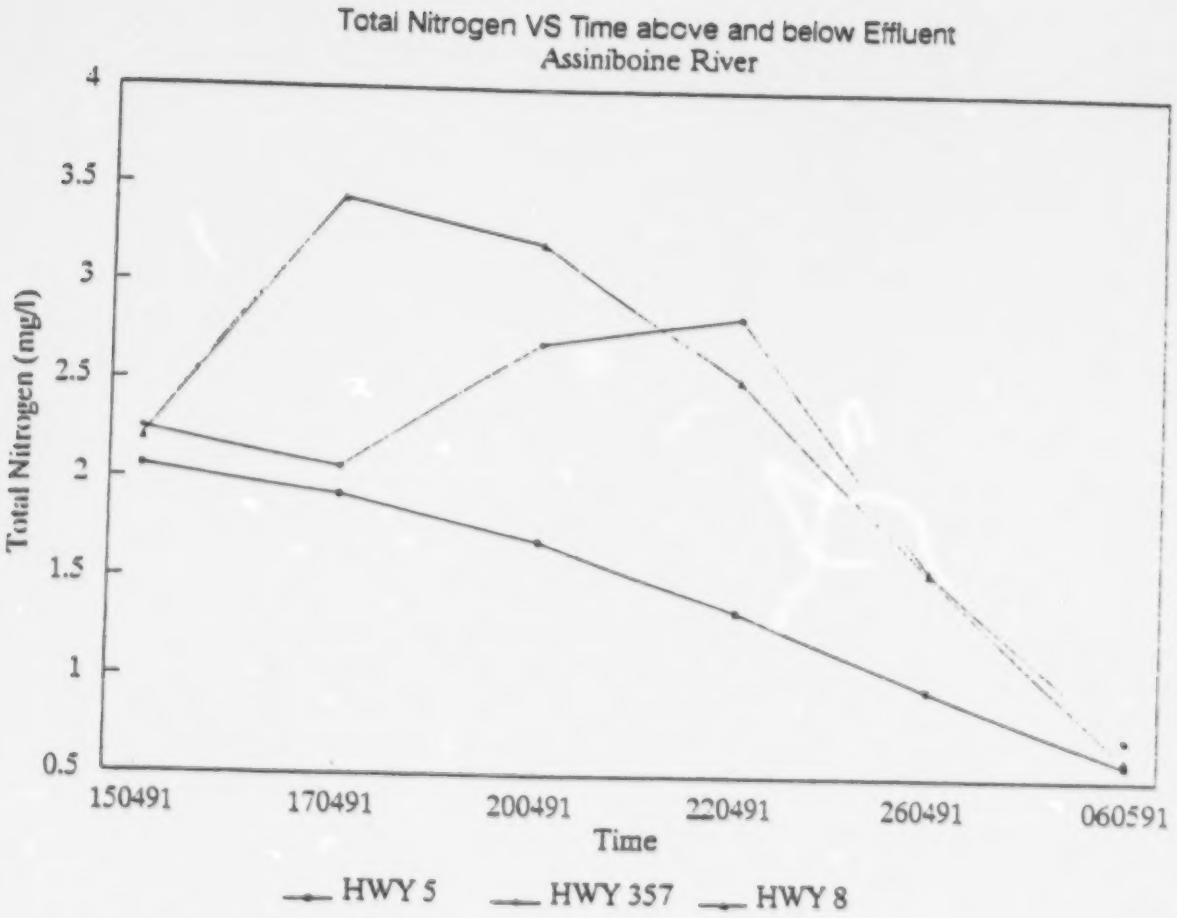

Chloride conc. VS Time above and below Effluent
Assiniboine River
50
45
40
35
30
25
20
15
10
Chloride (mg/l)
150491
170491
200491
220491
260491
060591
Time
HWY 5
HWY 357
HWY 8

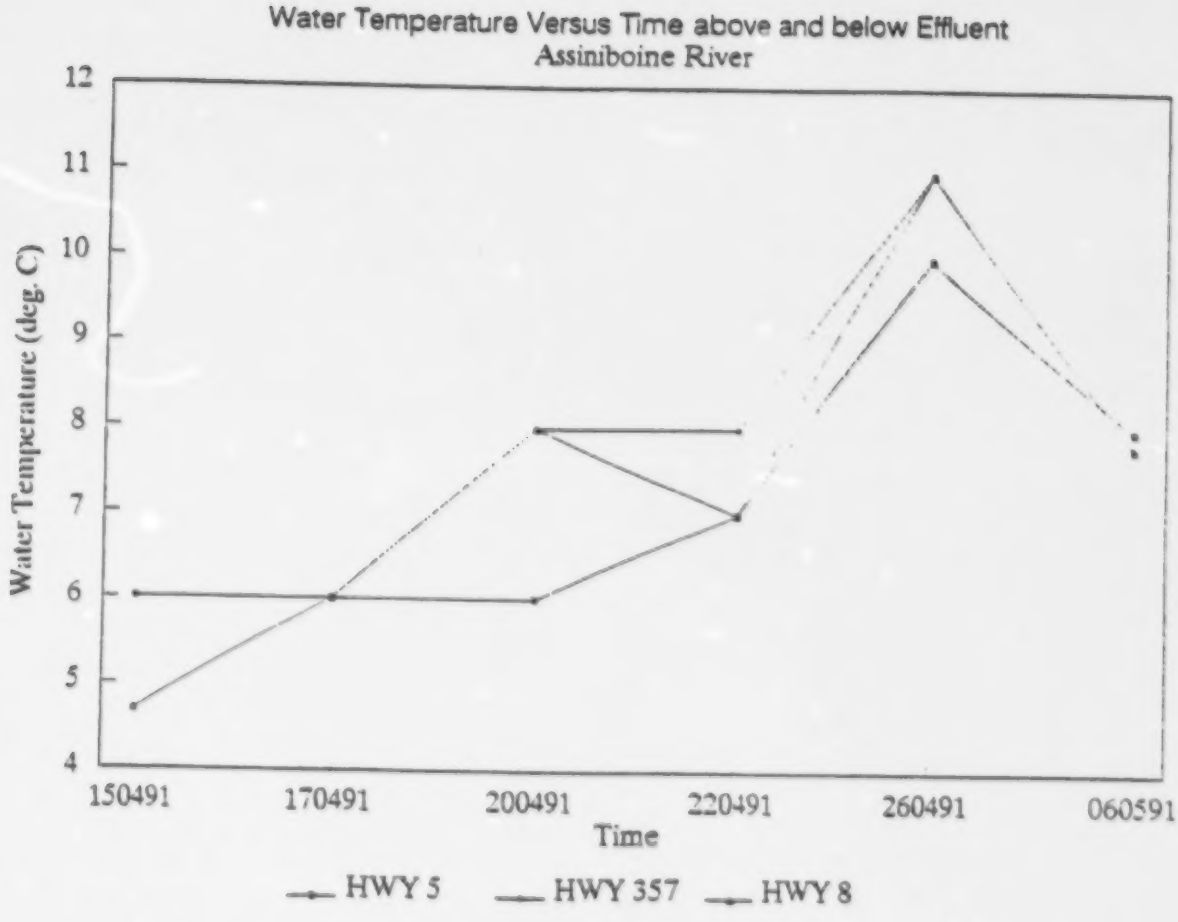
DOC conc. VS Time above and below Effluent




Sulphate conc. VS Time above and below Effluent
Assiniboine River
170
160
150
140
130
120
110
100
90
80
Sulphate (mg/l)
150491
170491
200491
220491
260491
060591
Time
HWY 5
HWY 357
HWY 8


Total Phosphorous VS Time above and below Effluent
Assiniboine River
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Total Phosphorous (mg/l)
150491
170491
200491
220491
260491
060591
Time
HWY 5
HWY 357
HWY 8

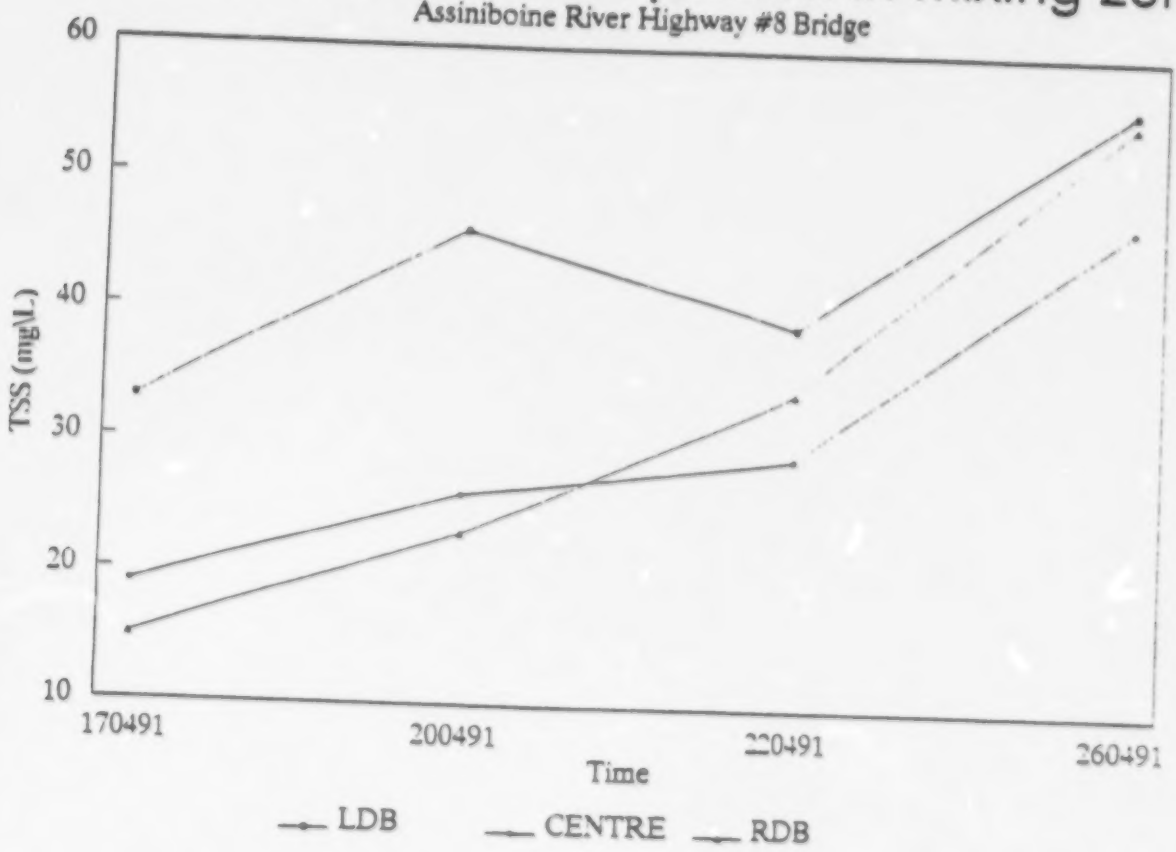

Total Nitrogen VS Time above and below Effluent
Assiniboine River
Total Nitrogen (mg/l)
4
3.5
3
2.5
2
1.5
1
0.5
150491
170491
200491
220491
260491
060591
Time
HWY 5
HWY 357
HWY 8


Water Temperature Versus Time above and below Effluent
Assiniboine River
Water Temperature (deg. C)
12
11
10
9
8
7
6
5
4
150491
170491
200491
220491
260491
060591
Time
HWY 5
HWY 357
HWY 8

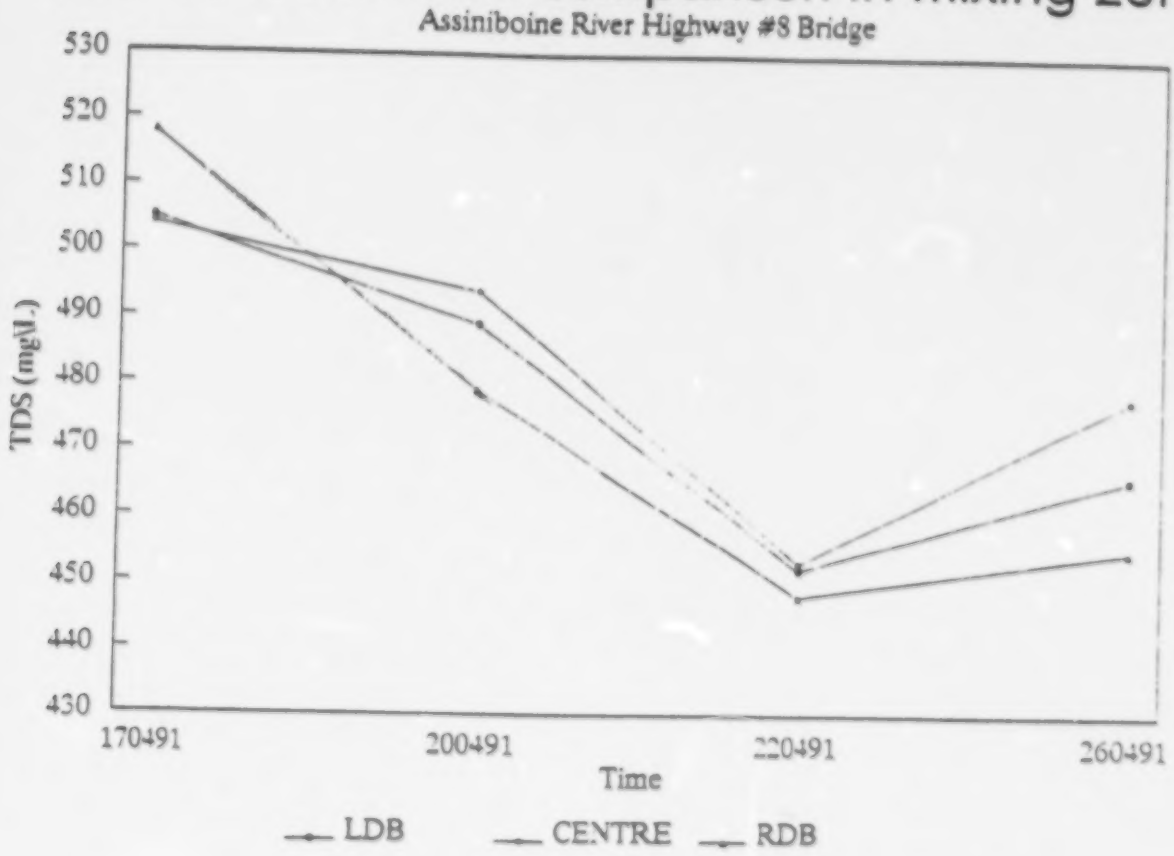
APPENDIX 4

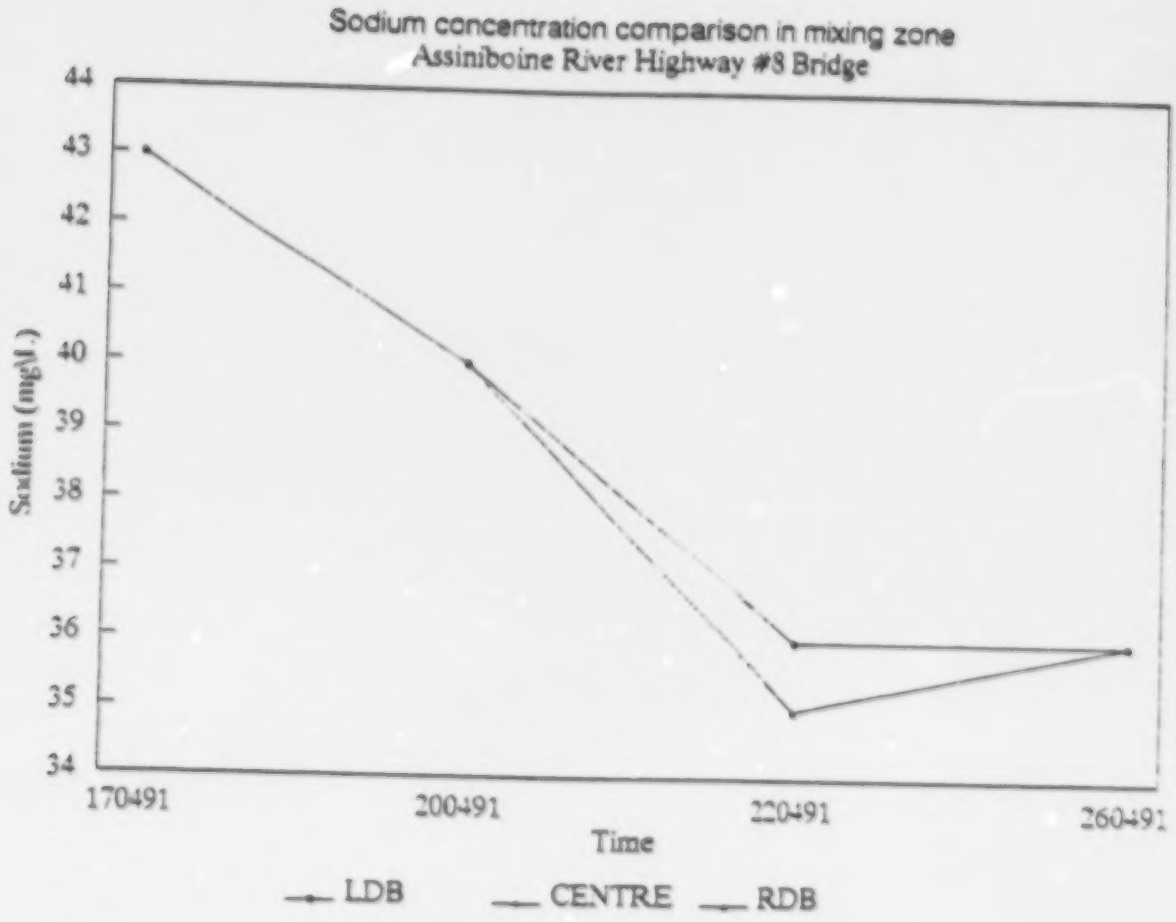
CONCENTRATION VERSUS TIME GRAPHS OF SPRING DATA FOR MIXING ZONE SITES AT HIGHWAY #8 SITE.

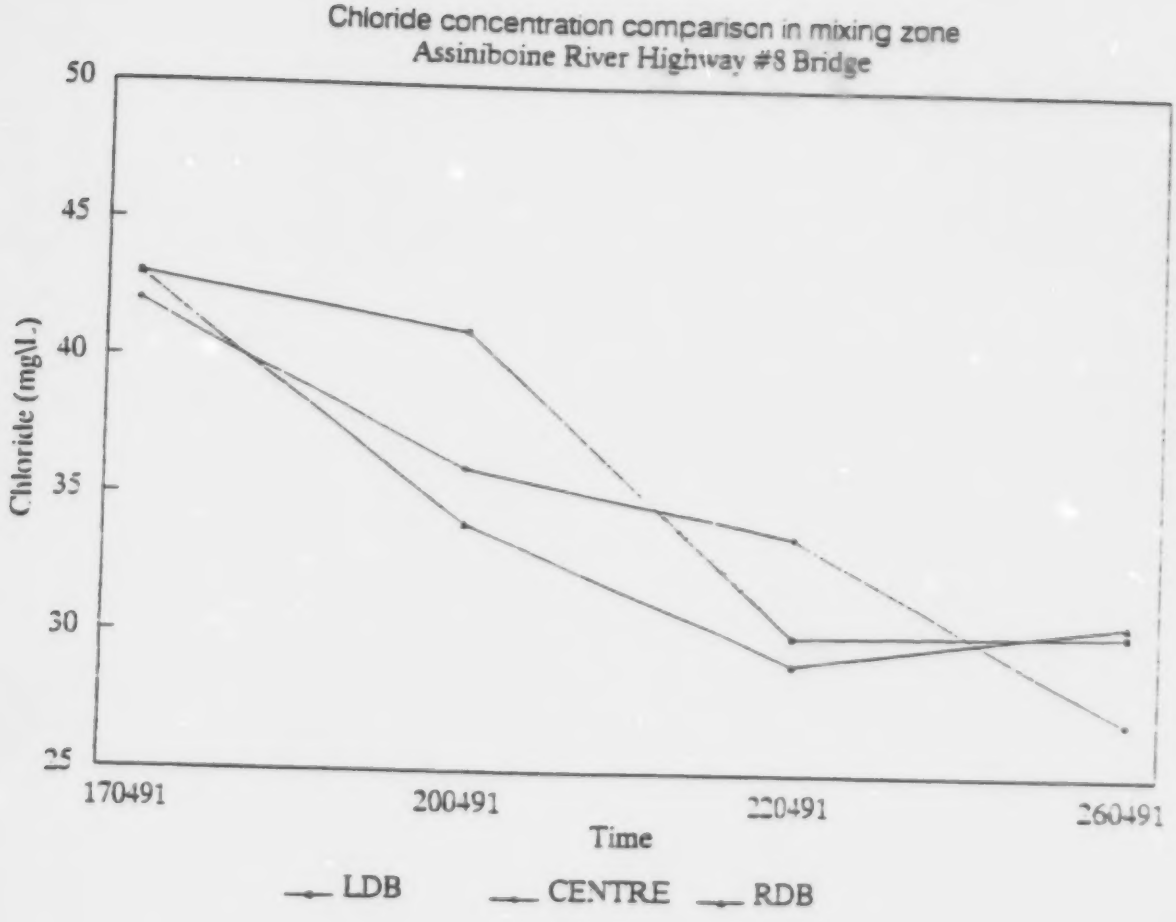
TSS concentration comparison in mixing zone

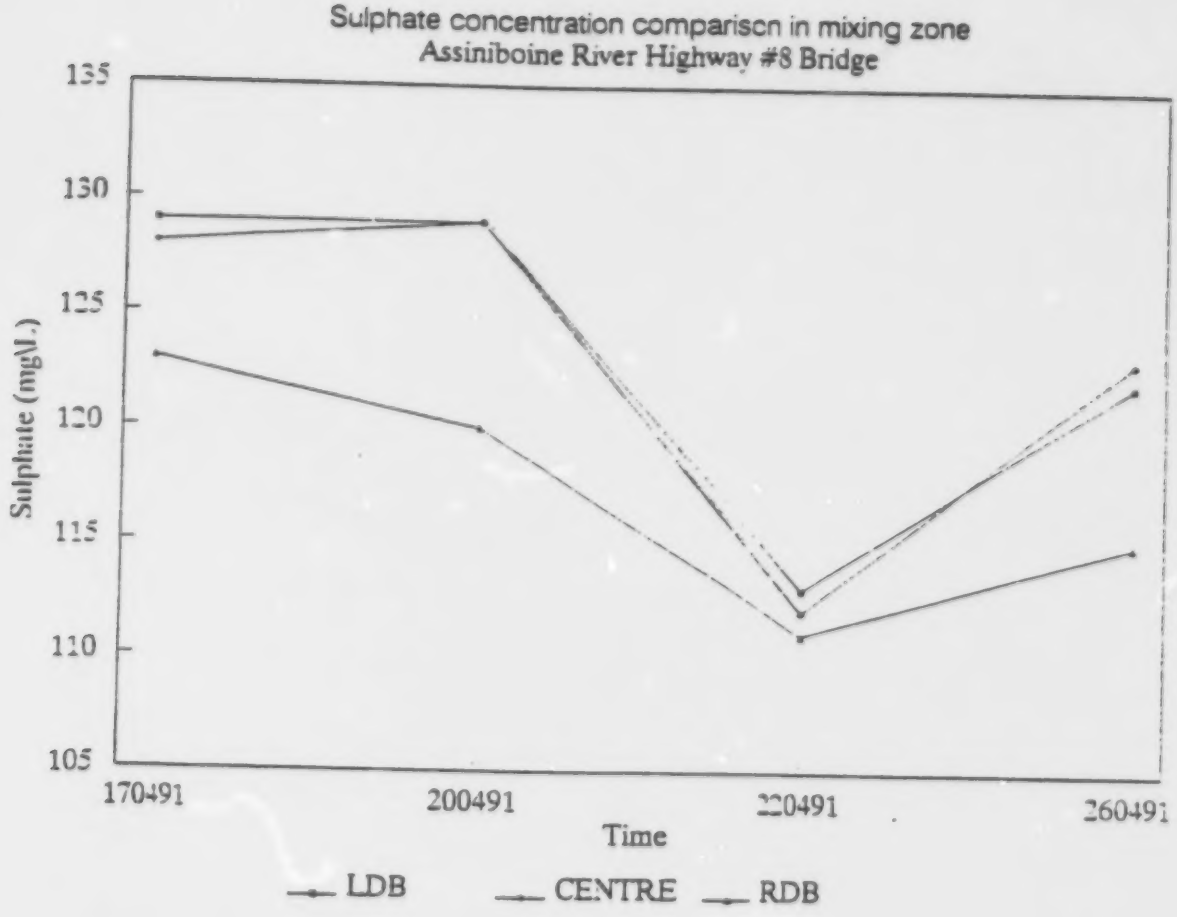


TDS concentration comparison in mixing zone

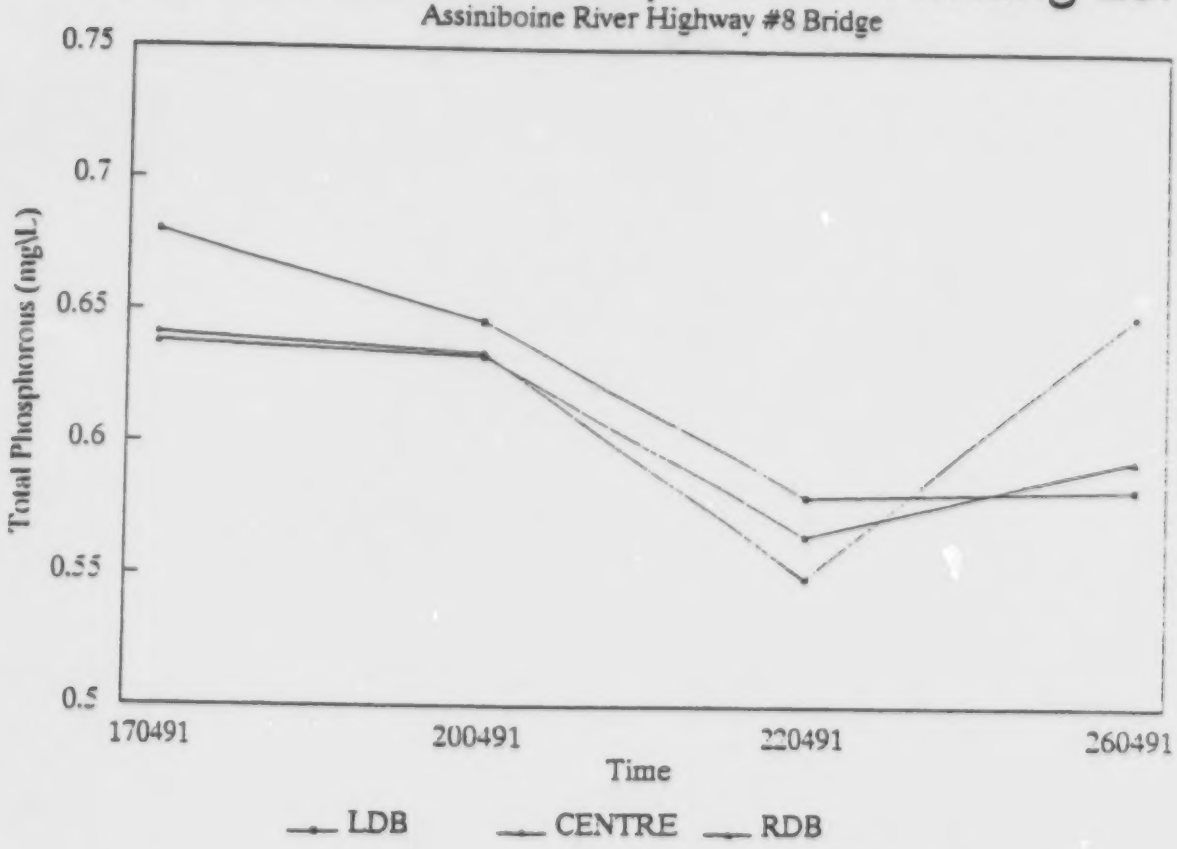



Sodium concentration comparison in mixing zone
Assiniboine River Highway #8 Bridge
Sodium (mg/L)
44
43
42
41
40
39
38
37
36
35
34
170491
200491
220491
260491
Time
LDB
CENTRE
RDB

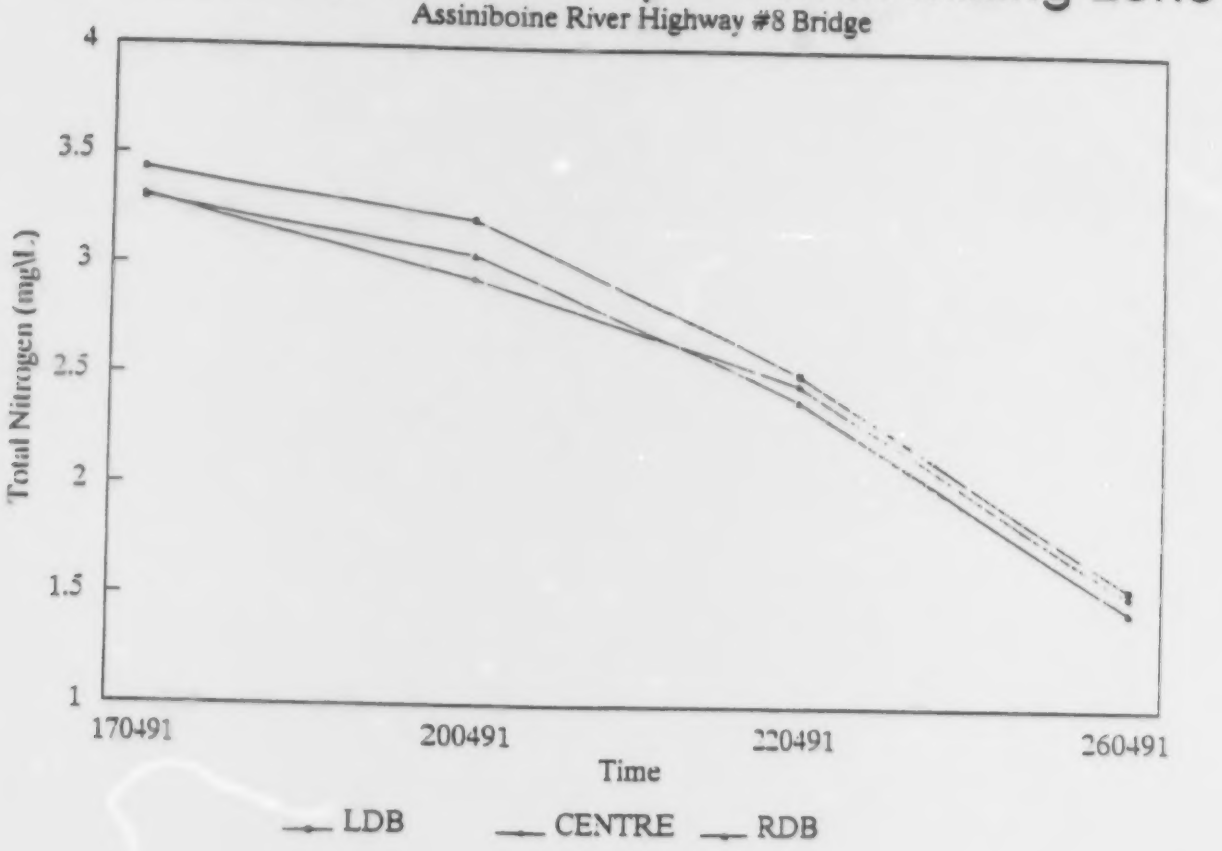

Chloride concentration comparison in mixing zone
Assiniboine River Highway #8 Bridge
50
45
40
35
30
25
Chloride (mg/L)
170491
200491
220491
260491
Time
LDB
CENTRE
RDB


Sulphate concentration comparison in mixing zone
Assiniboine River Highway #8 Bridge
135
130
125
120
115
110
105
Sulphate (mg/L)
170491
200491
220491
260491
Time
LDB
CENTRE
RDB

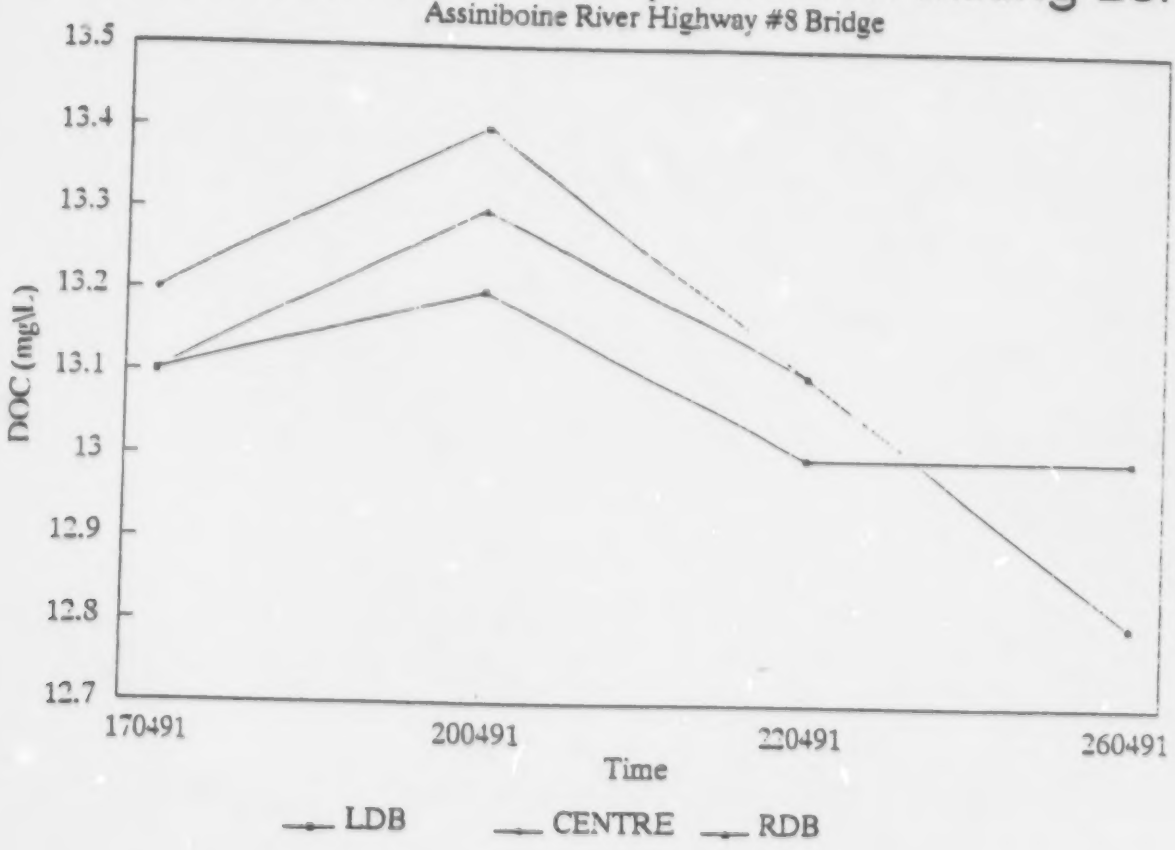
TP concentration comparison in mixing zone

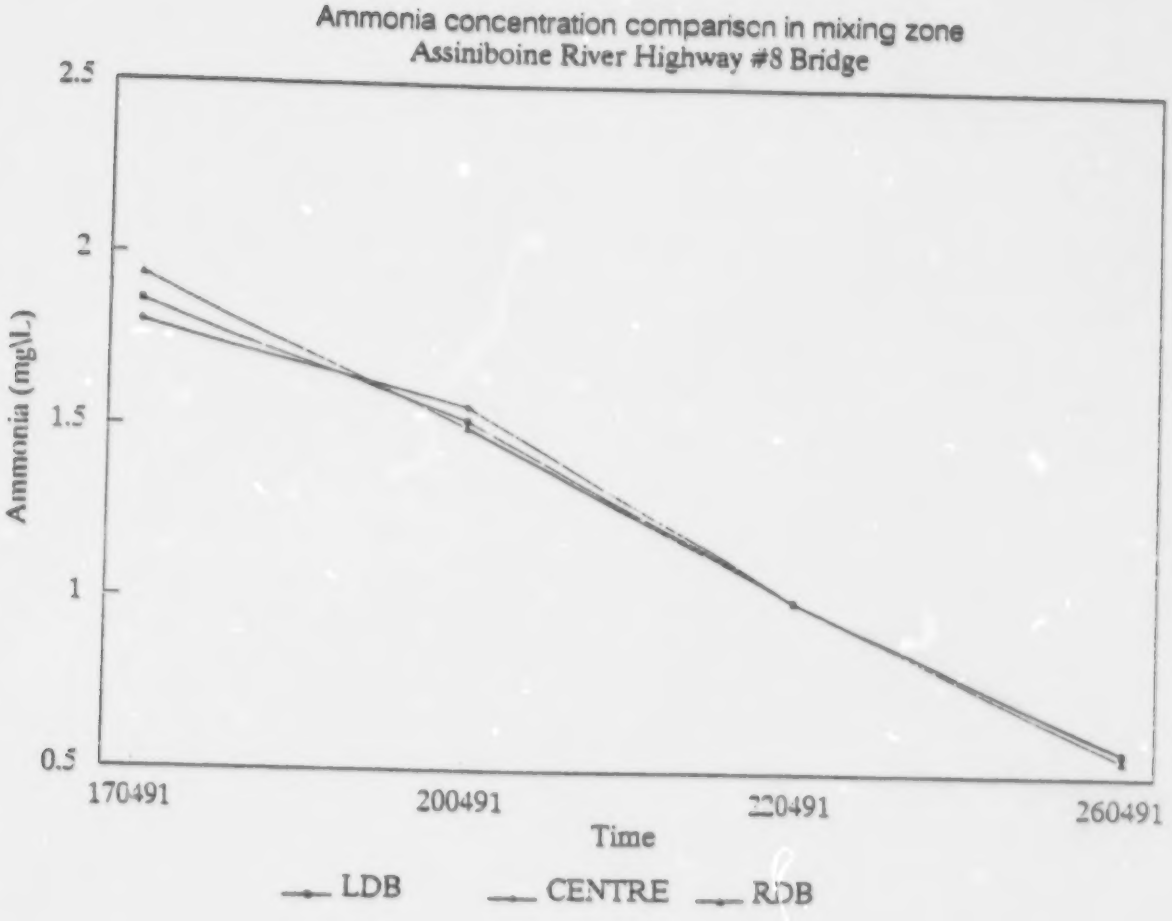


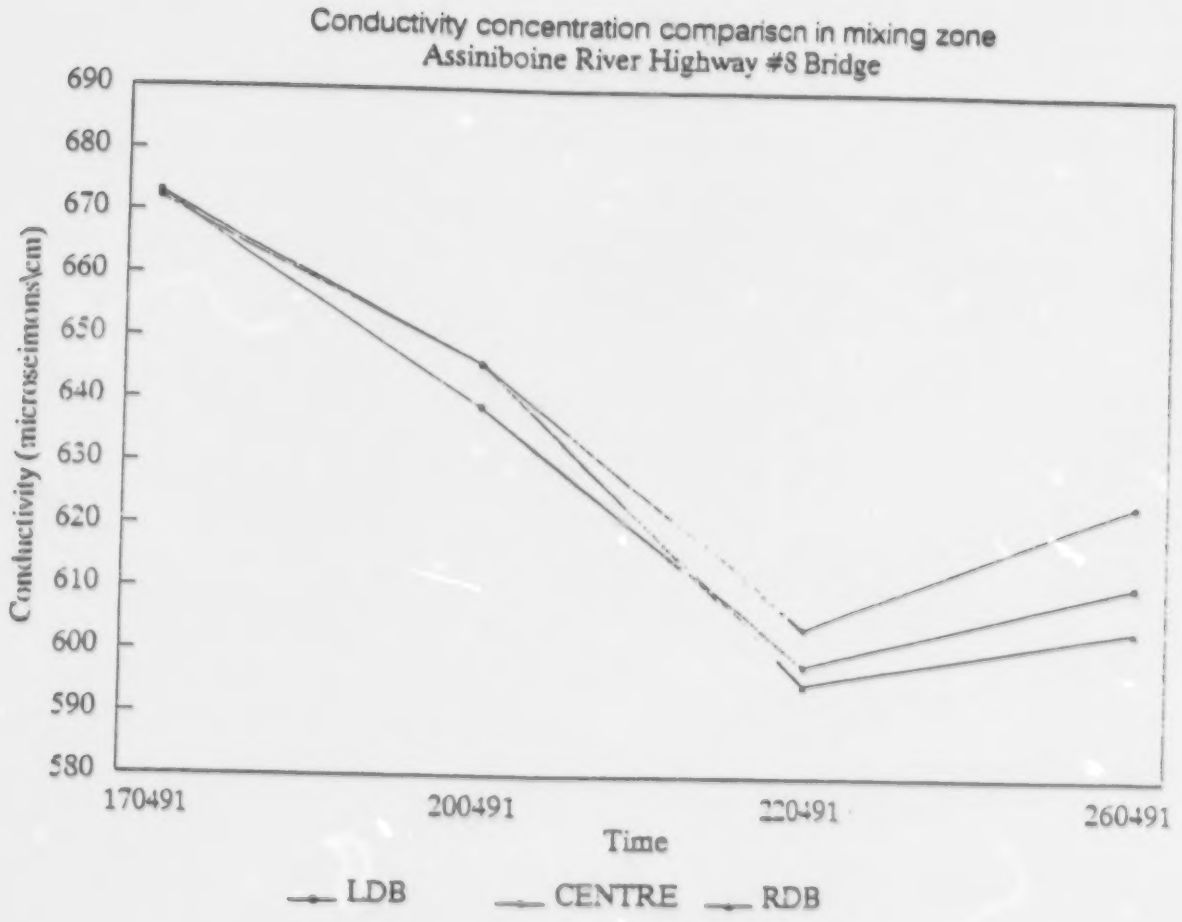
TN concentration comparison in mixing zone



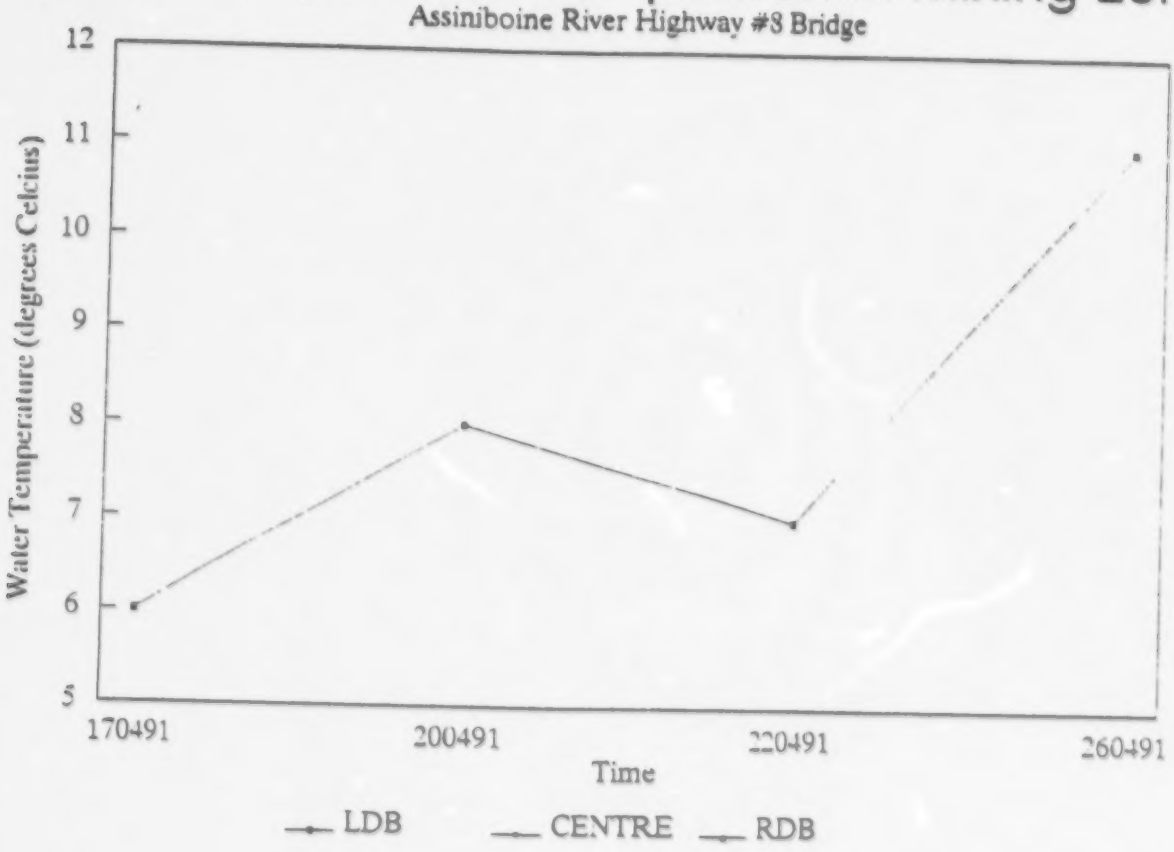
DOC concentration comparison in mixing zone



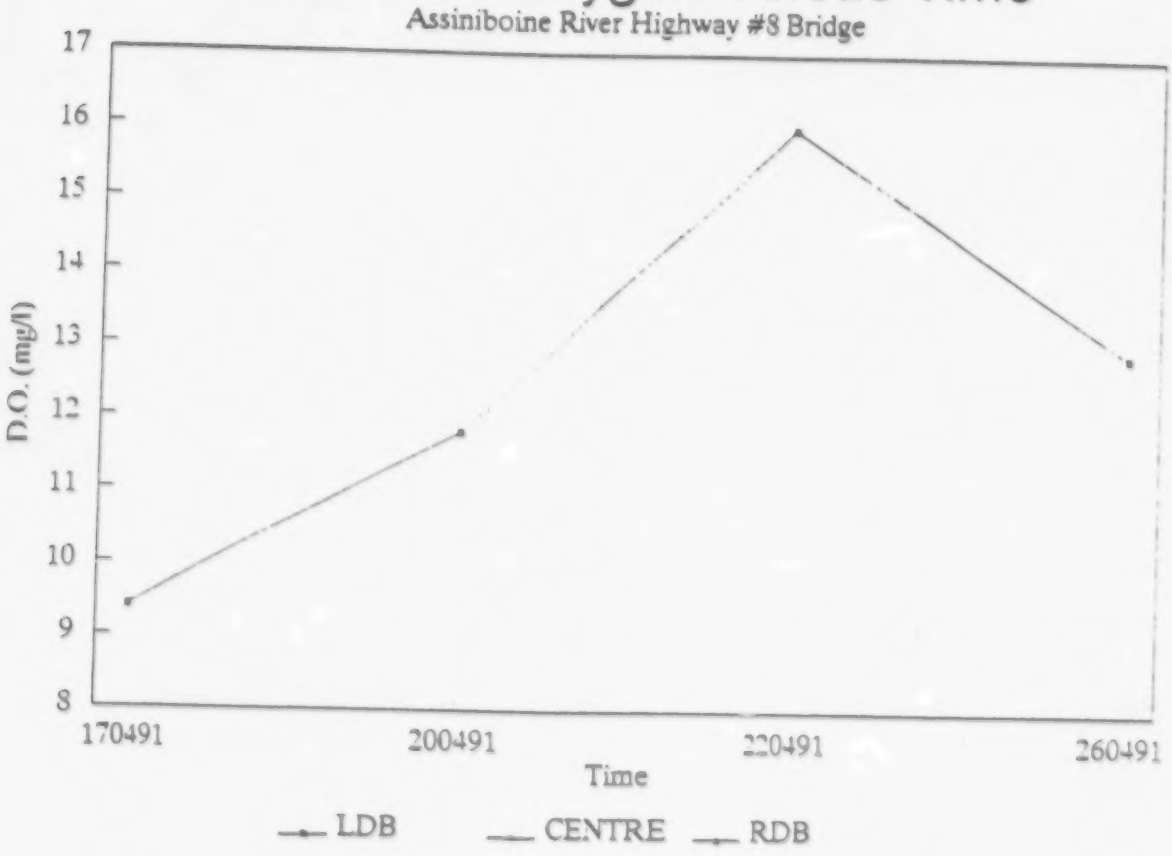

Ammonia concentration comparison in mixing zone
Assiniboine River Highway #8 Bridge
2.5
2
1.5
1
0.5
Ammonia (mg\L)
170491
200491
220491
260491
Time
LDB
CENTRE
RDB


Conductivity concentration comparison in mixing zone
Assiniboine River Highway #8 Bridge
690
680
670
660
650
640
630
620
610
600
590
580
Conductivity (microsiemens\cm)
170491
200491
220491
260491
Time
LDB
CENTRE
RDB

Water Temperature comparison in mixing zone

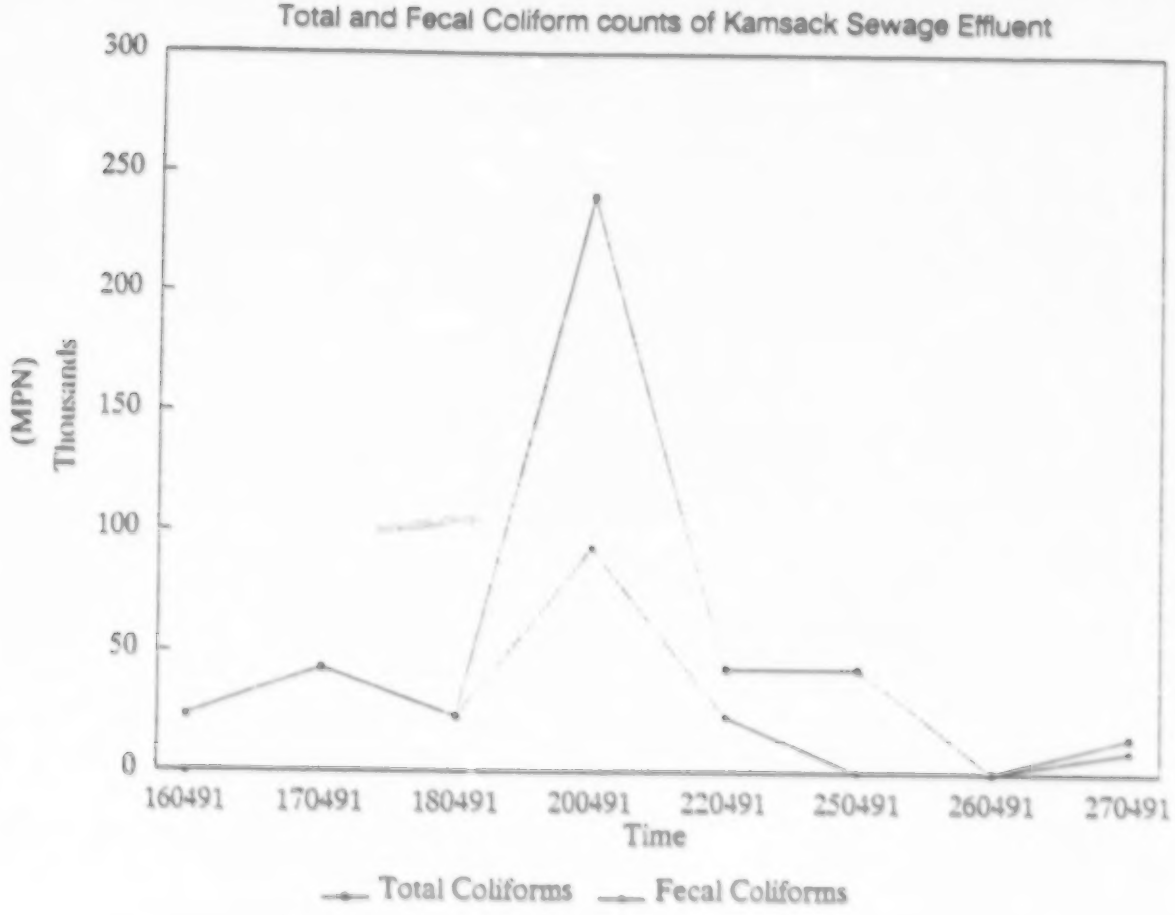


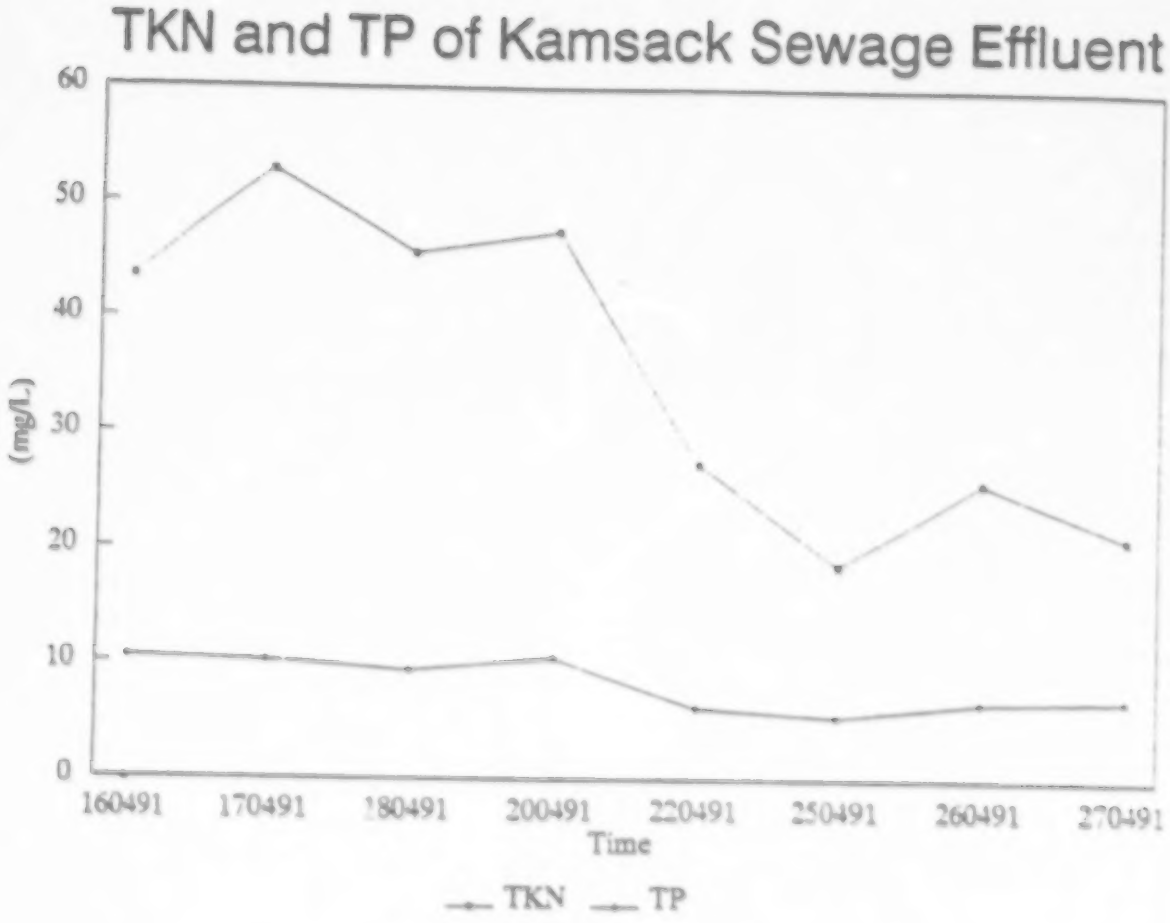
Dissolved Oxygen Versus Time



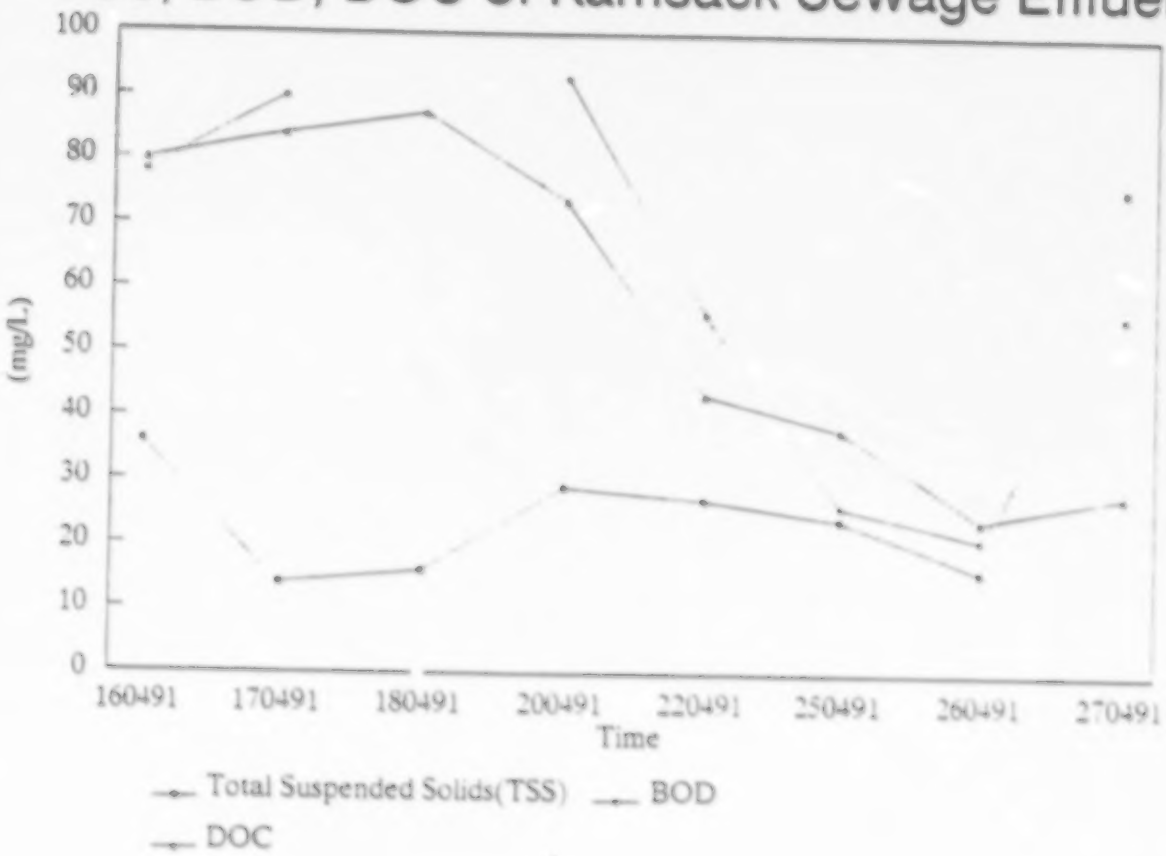
APPENDIX 5

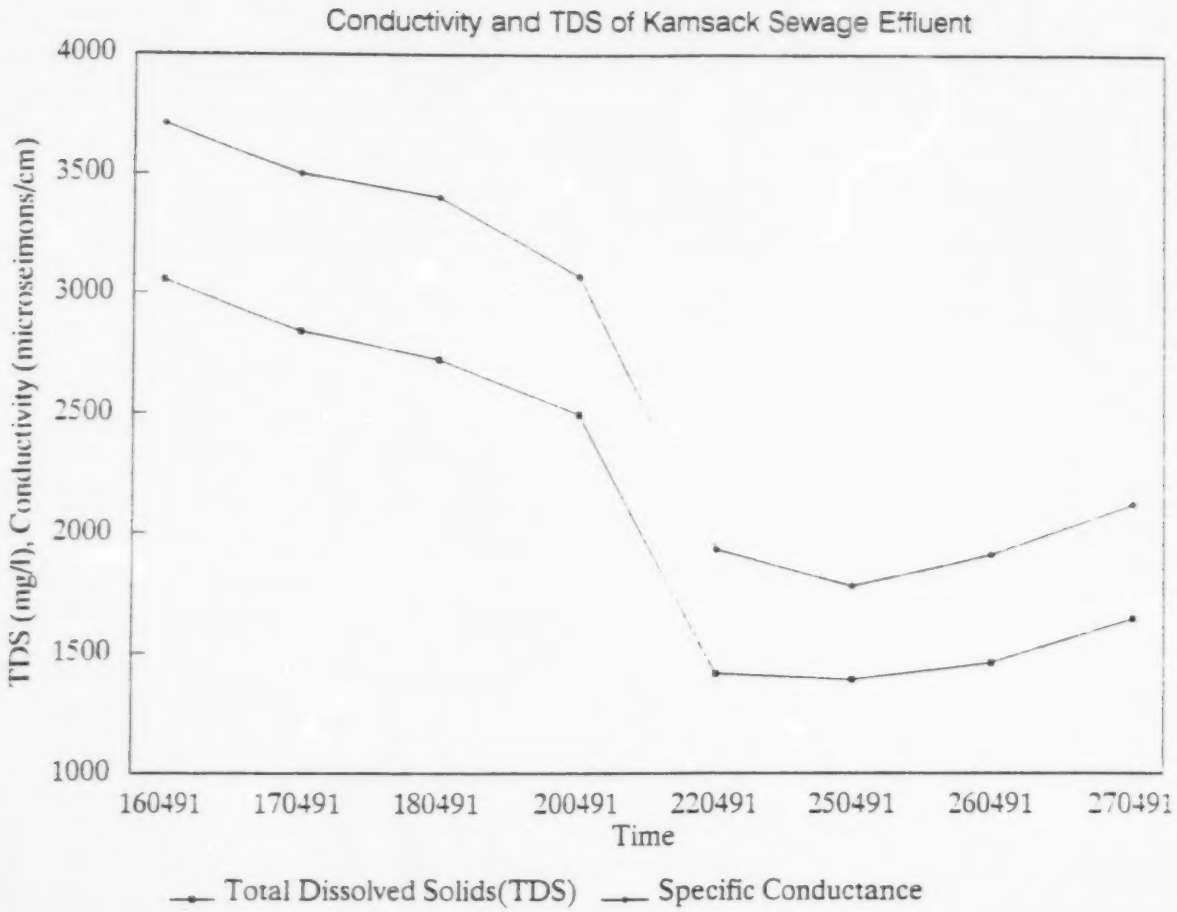
CONCENTRATION VERSUS TIME GRAPHS KAMSACKS'S FINAL SEWAGE EFFLUENT FROM THE SPRING MONITORING PROGRAM.


Total and Fecal Coliform counts of Kamsack Sewage Effluent
300
250
200
150
100
50
0
(MPN)
Thousands
160491
170491
180491
200491
220491
250491
260491
270491
Time
Total Coliforms
Fecal Coliforms

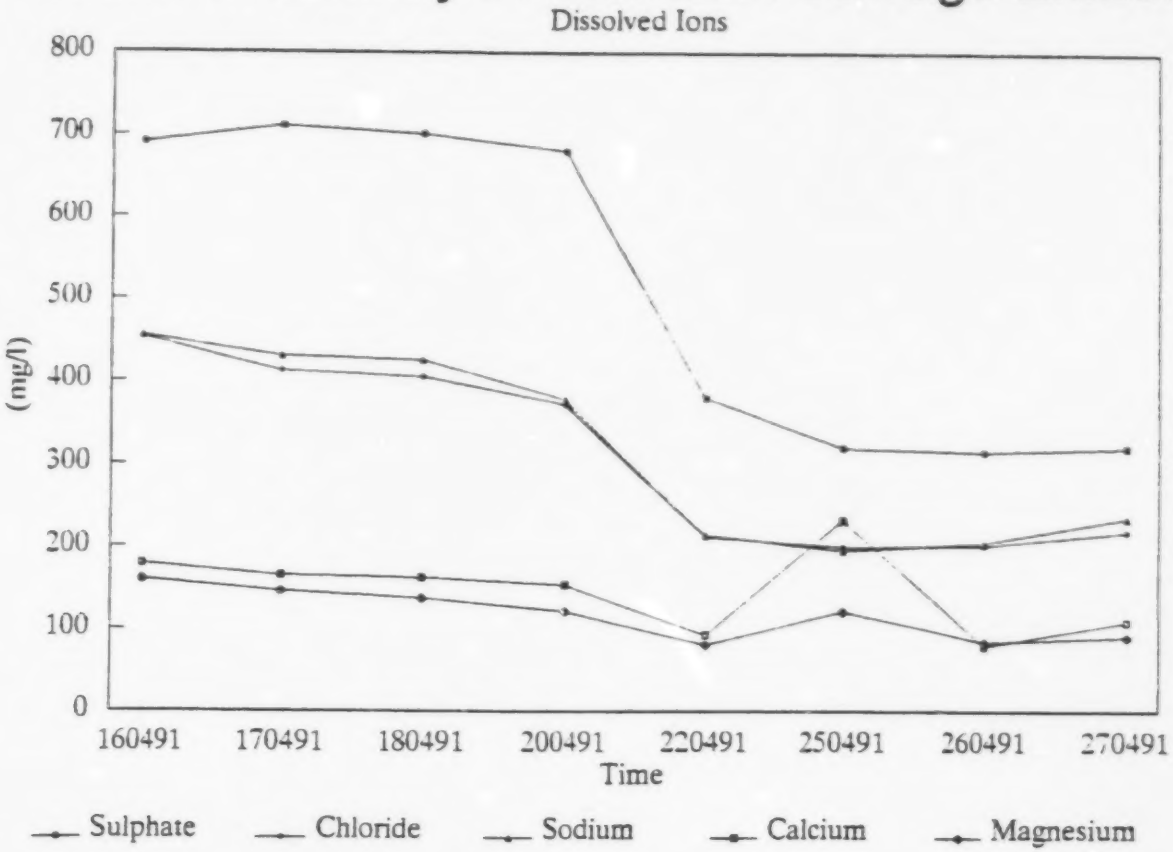

TKN and TP of Kamsack Sewage Effluent
60
50
40
30
20
10
0
(mg/L)
160491
170491
180491
200491
220491
250491
260491
270491
Time
TKN
TP

TSS, BOD, DOC of Kamsack Sewage Effluent



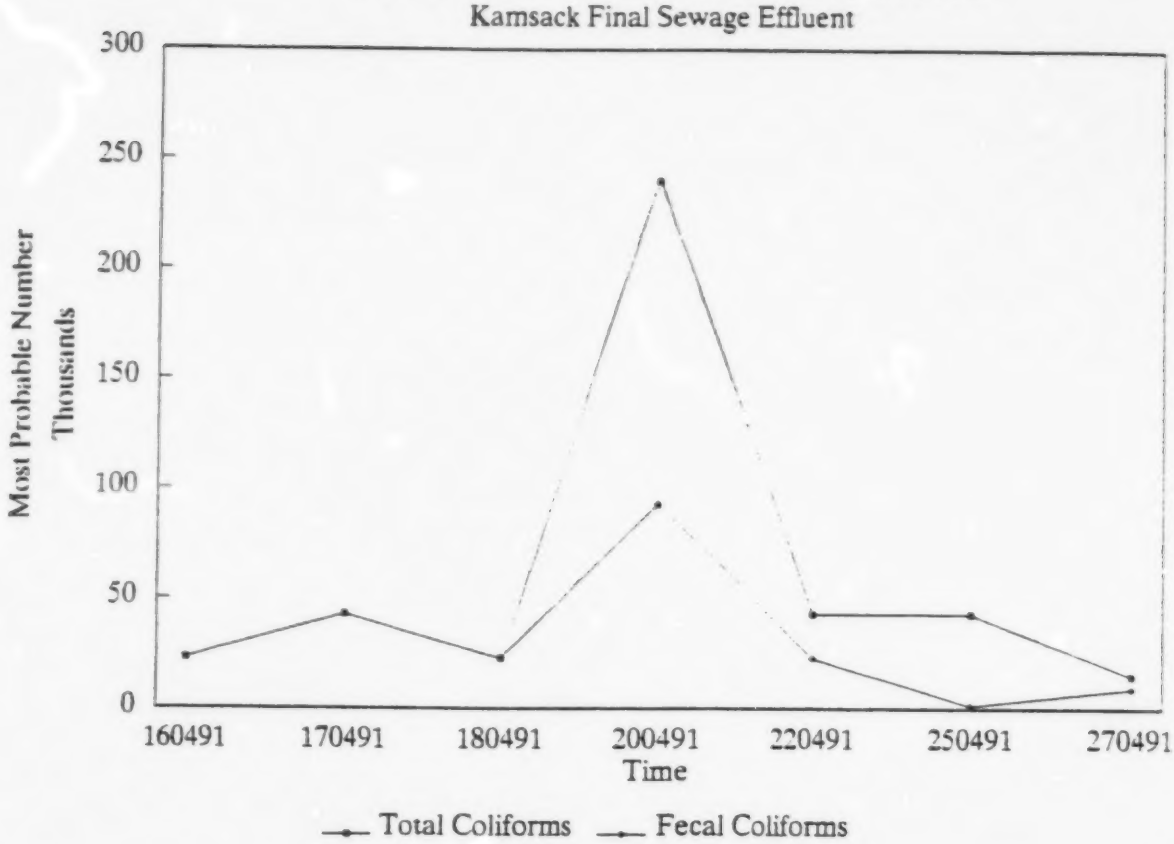

Conductivity and TDS of Kamsack Sewage Effluent
4000
3500
3000
2500
2000
1500
1000
TDS (mg/l), Conductivity (microseimons/cm)
160491
170491
180491
200491
220491
250491
260491
270491
Time
Total Dissolved Solids(TDS)
Specific Conductance

Water Chemistry of Kamsack Sewage Effluent



Total and Fecal Coliforms

Kamsack Final Sewage Effluent



APPENDIX 6

THE FALL MONITORING PROGRAM DATA

Site: Assiniboine River at Highway #357 (Site 3).

Parameter	Parameter Codes	Dates Samples Collected 211091	251091	271091	051191
D.O.	08101W	11.4		12.2	13.4
TEMP.	020612	2.3	2	1.5	0
AMMONIA	07540?				
DOC	06104L				
TN	07602?				
TP	154???	0.082	0.082	0.092	0.108
SULPHATE	16????	172	173	157	157
CHLORIDE	17??4?	17	16	18	
SODIUM	11????	42	42	42	47
TDS	00????	771	751	748	807
SPEC. COND	22041?	887	882	880	936
BOD	08????	2		3	4?
TKN	07????	0.?	1.7	1.3	1.5
AMMONIA	07????	0.04		0.02	0.02
TP	154???		0.05	0.14	0.1?
TSS	10406?	9	17	14	53
FC	26004?	???		20	???
FC	26014?	???	12	???	
DOC	0611??	14	14	14	15
CA	20????	99	99	97	99
MG	12????	47	48	48	49

All values are in mg/l except Spec. Cond. (microsiemens) and Temperature (degrees celcius).

All analysis by CEPS except Total Phosphorous code 154??? by Environment Canada.

Site: Assiniboine River at Highway #8

Parameter	Parameter Codes	Dates Samples Were Collected			
		211091	221091	271091	051191
D.O.	08102[illegible]	10.4		10	10.4
TEMP.	02061[illegible]	3	2	1	0.5
AMMONIA	07540[illegible]				
DOC	06134[illegible]				
[illegible]	07602[illegible]				
TP	15442[illegible]	0.115	0.116	0.117	0.172
SULPHATE	16031[illegible]	129	142	155	395
CHLORIDE	17154[illegible]	28	27	30	110
SODIUM	11[illegible]	51	52	57	147
TDS	20216[illegible]	768	751	780	1256
SPEC. COND	22041[illegible]	864	885	942	1610
BOD	08202[illegible]	2		2	2
TKN	07104[illegible]	0.[illegible]	2	2.6	2.4
AMMONIA	07324[illegible]	0.24		0.18	0.3
TP	15402[illegible]	0.08	0.1	0.25	0.26
TSS	10406[illegible]	4	11	33	8
[illegible]	26004[illegible]	20		50 1100	
FC	26011[illegible]	110		5	10
DOC	26112[illegible]	16	15	16	19
CA	20100[illegible]	82	81	87	116
MG	12001[illegible]	47	49	52	84

All values are in mg/l except Spec. Cond. (microsiemen and Temperature degrees celcius)

All analysis by ERS Except Total Phosphorous code 15442[illegible] by Environment Canada.

Site: Assiniboine River at Highway #5

Parameter	Parameter Code	Dates Samples Were Collected 111091	211091	271091	051191
D.O.	08101W	8.9		10.2	9.4
TEMP.	020612	3	1	2	0
AMMONIA	075402				
DOC	06104L				
TN	07602L				
TP	154[illegible]	0.072	0.266	0.074	0.069
SULPHATE	16204L	228	223	206	129
CHLORIDE	17306L	61	60	65	12
SODIUM	[illegible]	95	93	96	39
TDS	00210L	950		935	720
SPEC. COND	20041[illegible]	1114	1230	1176	822
BOD	08201L	1.8		2.8	2.4
TKN	07101[illegible]	0.[illegible]	1.3	[illegible]	1.5
AMMONIA	07510L	0.04		0.36	0.01
TP	15402L	0.08	0.12	0.[illegible]	0.[illegible]
TSS	10405L	7	[illegible]	5	[illegible]
[illegible]	16004L	[illegible]		4	20
FC	16011L	[illegible]	12	110	
DOC	06112L	15	14	11	13
CA	20108L	87	80	93	36
MG	12102L	56	54	60	47

All values are in mg/L except Spec. Cond. (microsiemen and Temperature degrees celcius)

All analysis by ESS Except Total Phosphorus code 154[illegible] by Environment Canada.

Site: Ramsack Sewage Lagoon Final Effluent (Site 4).

Parameter	Parameter Codes	Dates Samples Collected			
		211091	231091	271091	281091
D.O.	08101W				
TEMP.	02061P				
AMMONIA	07540P				
DOC	06104L				
TN	07602L				
TP	15422L		1.398	0.084	
SULPHATE	16308L	1160	1170	1070	1050
CHLORIDE	17304L	330	329	326	325
SODIUM	11104L	398	404	388	384
TDS	00206L	2811	2482	2430	2421
SPEC. COND	22841L	3300	3230	3260	3260
BOD	08202L	1.5		4.4	2.2
TKN	07015L	0.5	5.6	7.3	8.7
AMMONIA	07506L	0.09		4.15	5
TP	15405L	2.5	1.12	1.48	1.51
TSS	10405L	3	5	7	9
TC	16002L	280	40	230	200
FC	16012L	40	10.	90	70
DOC	06112L	27	27	26	28
CL	20120L	195	195	188	190
MG	12102L	180	180	175	175

All values are in mg/L except Spec. Cond. (microsiemon and Temperature (degrees celcius)

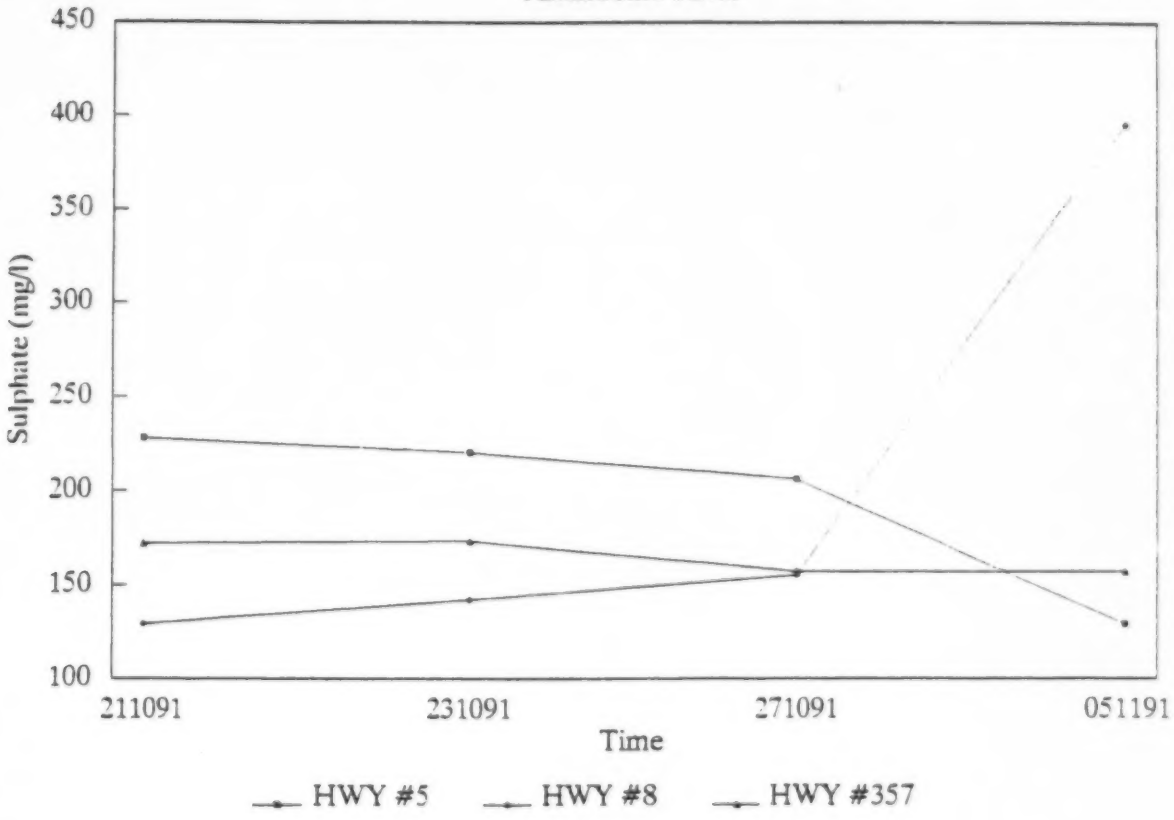
All analysis by NLS Except Total Phosphorous code 15422L by Environment Canada.

APPENDIX 7

CONCENTRATION VERSUS TIME GRAPHS OF THE FALL DATA OF SITES ON THE ASSINIBOINE RIVER ABOVE AND BELOW THE KAMSACK SEWAGE RELEASES.

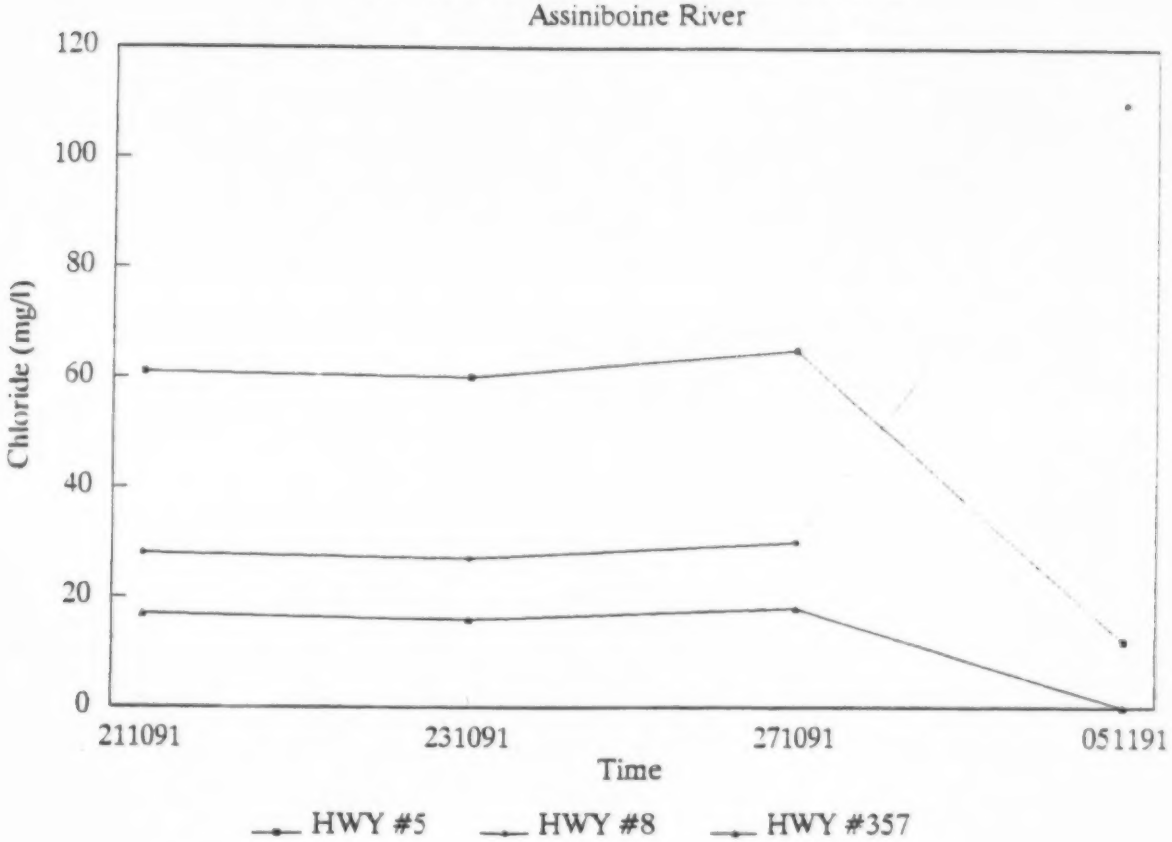
Sulphate Versus Time

Assiniboine River



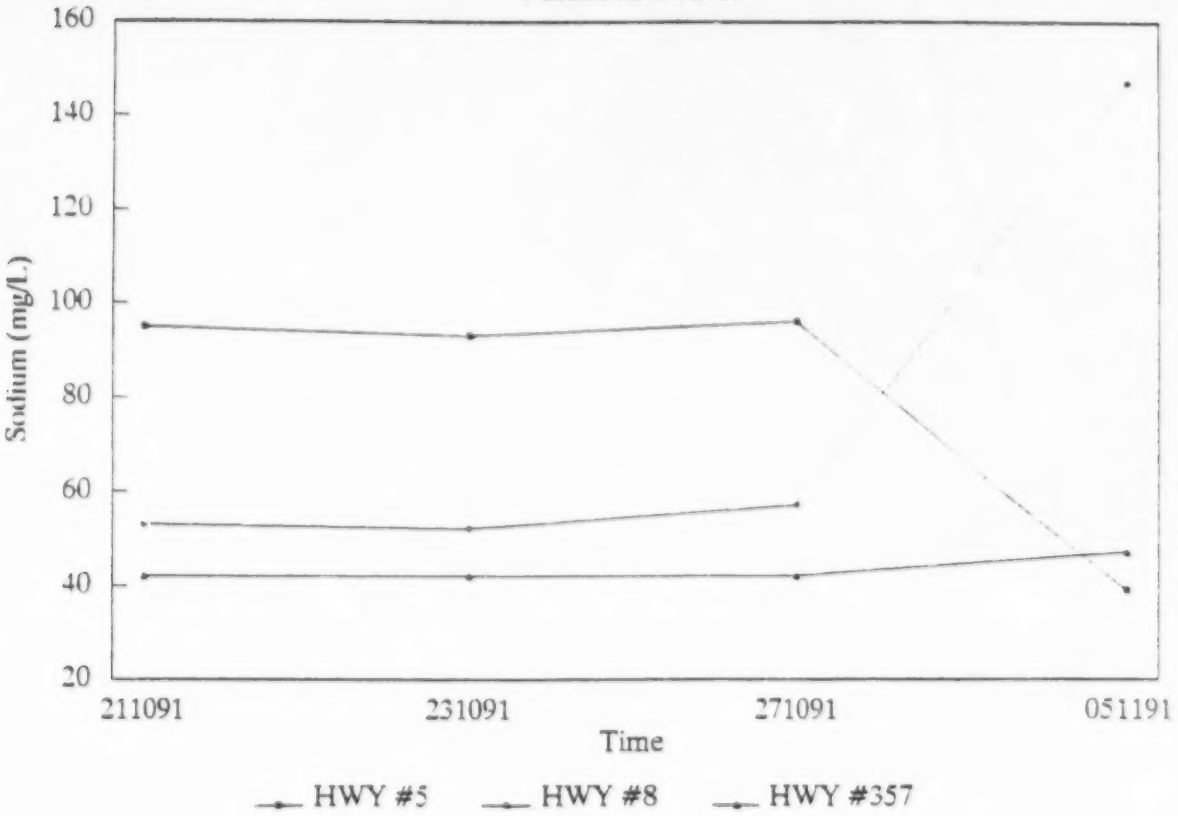
Chloride Versus Time

Assiniboine River

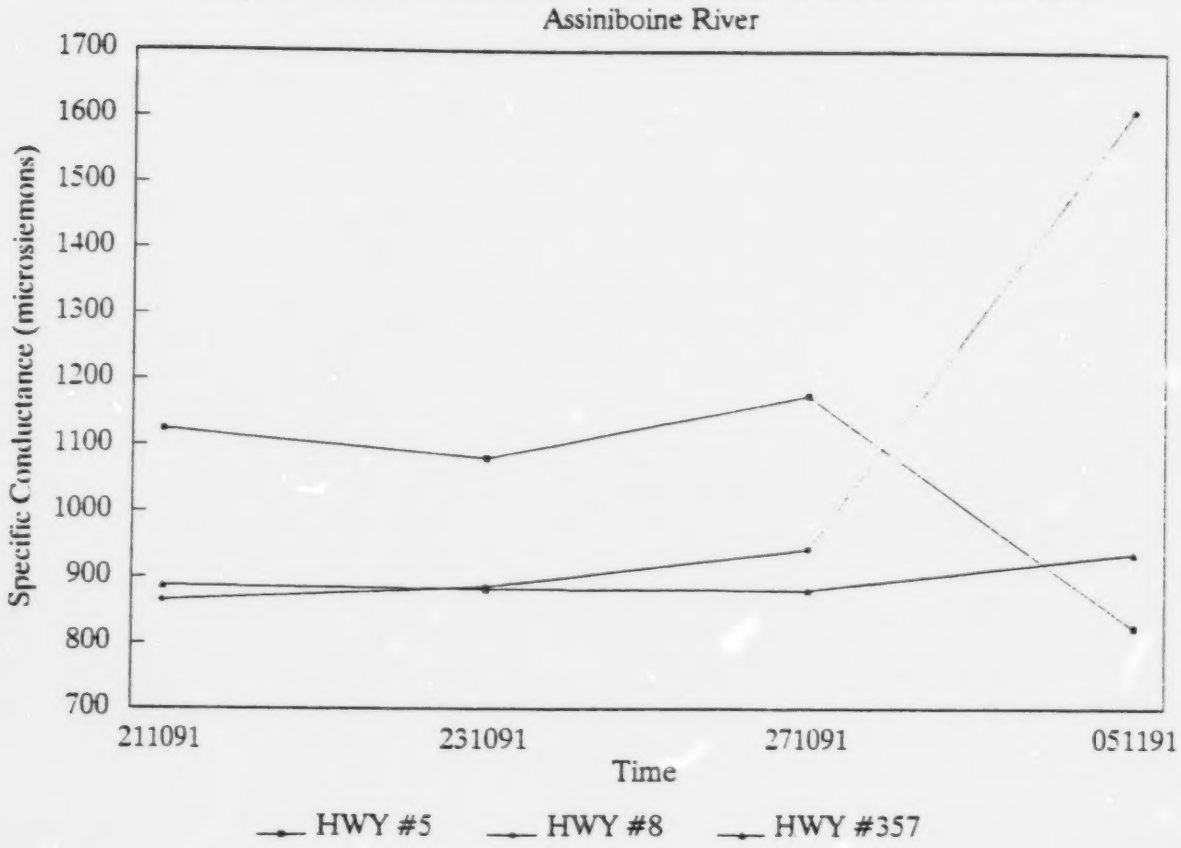


Sodium Versus Time

Assiniboine River

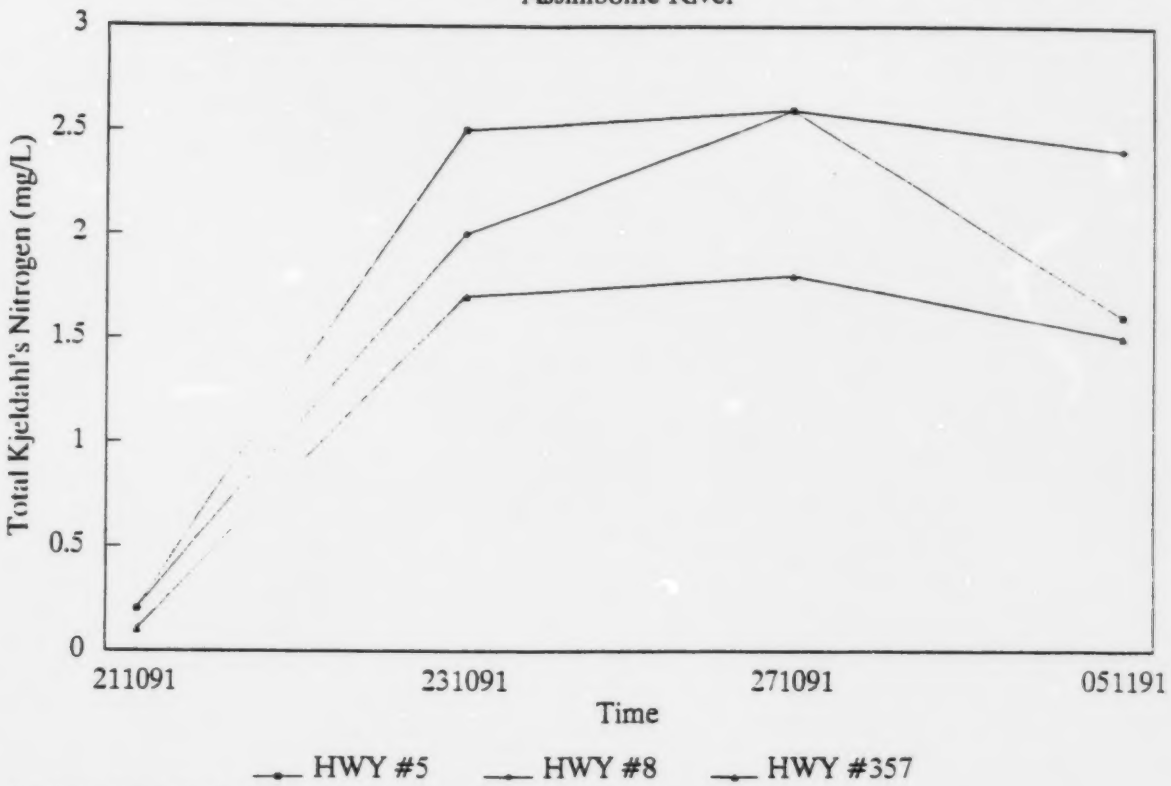


Specific Conductance Versus Time



Total Kjeldahl's Nitrogen Versus Time

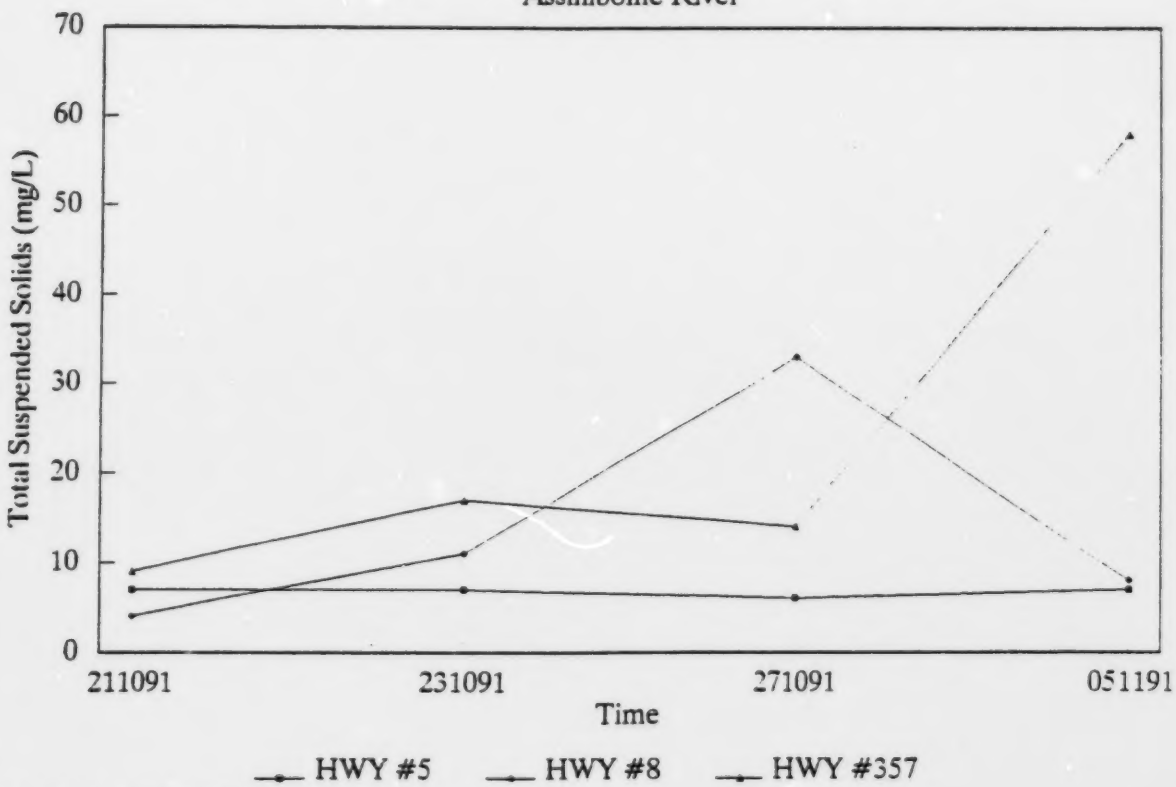
Assiniboine River



Analysis from Sask. Provincial Lab

Total Suspended Solids Versus Time

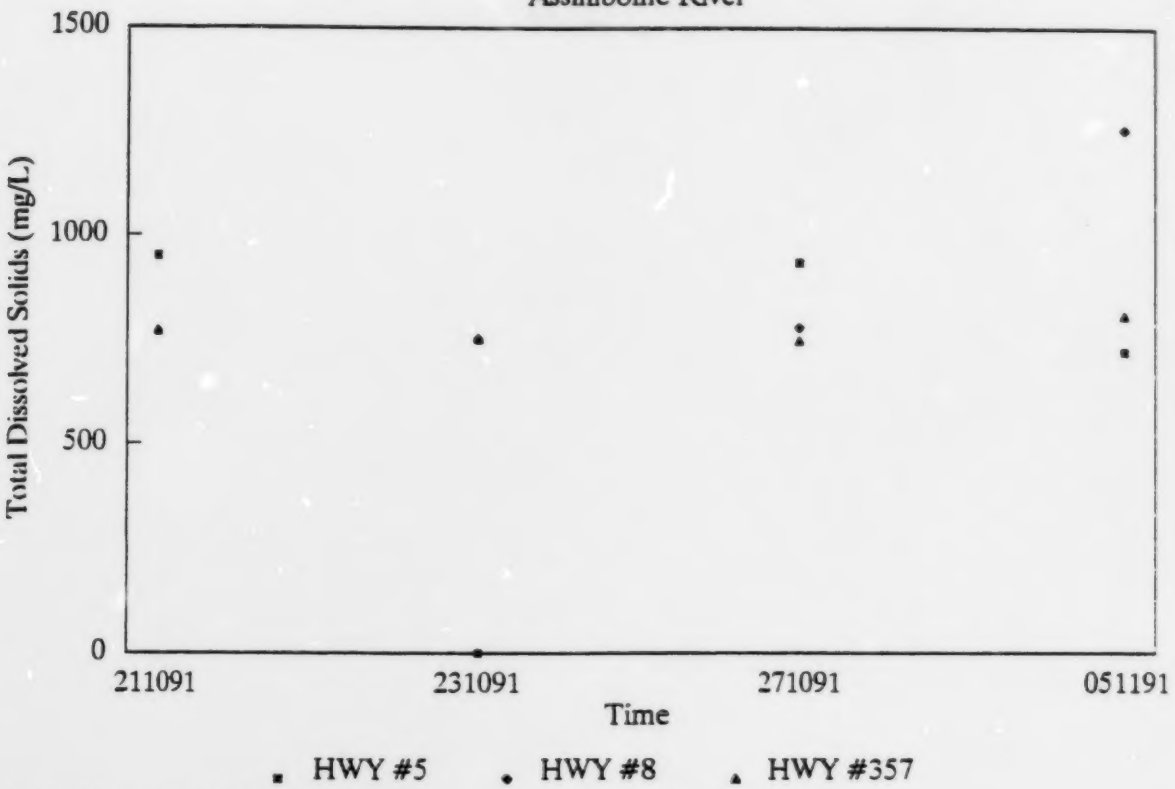
Assiniboine River



Analysis from Sask. Provincial Lab

Total Dissolved Solids Versus Time

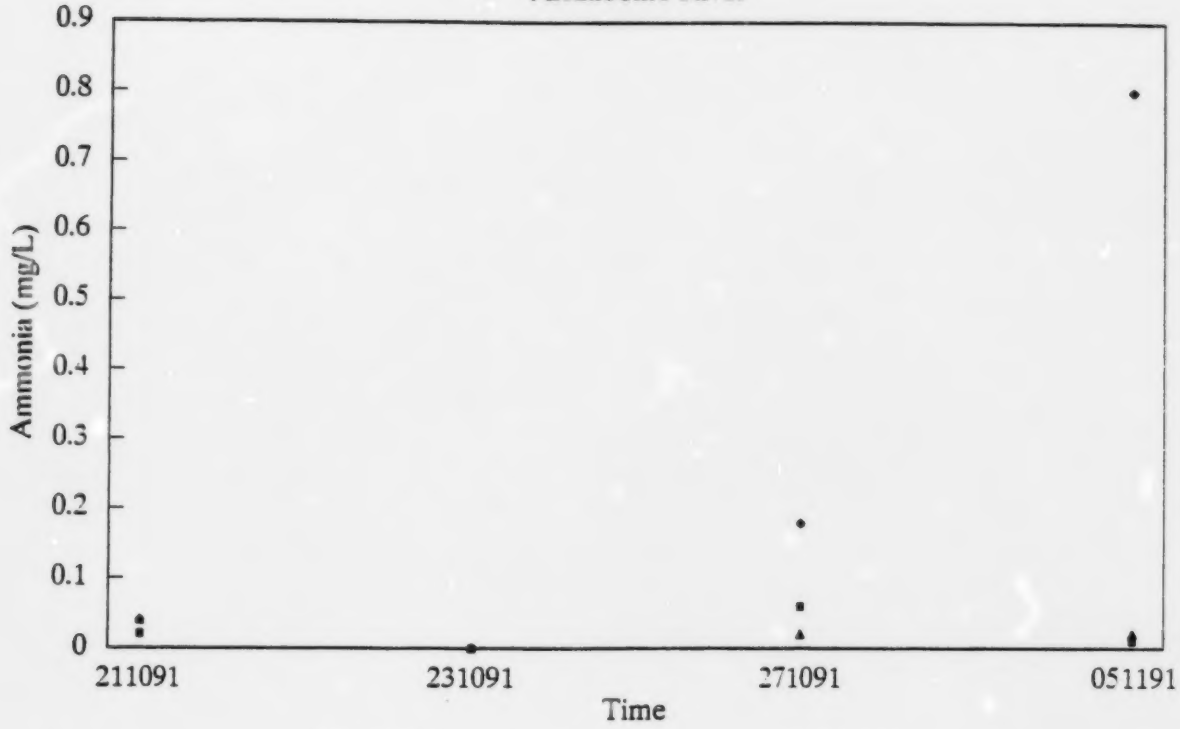
Assiniboine River



Analysis from Sask. Provincial Lab

Ammonia Versus Time

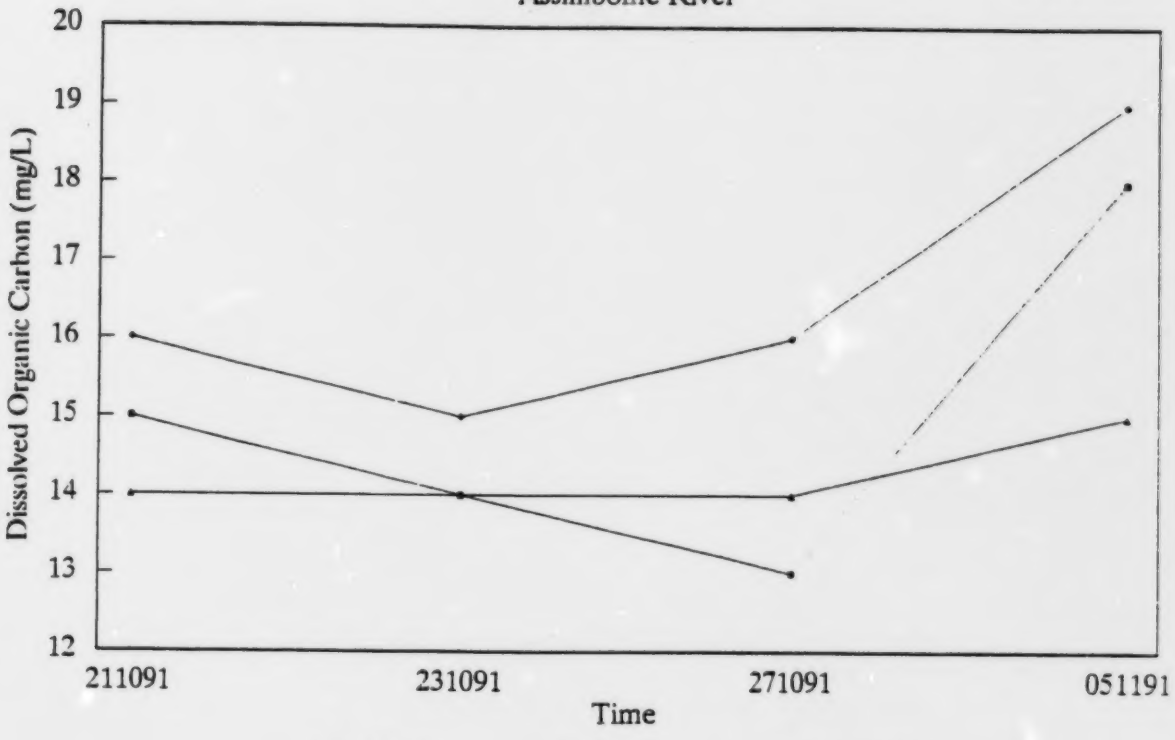
Assiniboine River



Analysis from Sask. Provincial Lab

Dissolved Organic Carbon Versus Time

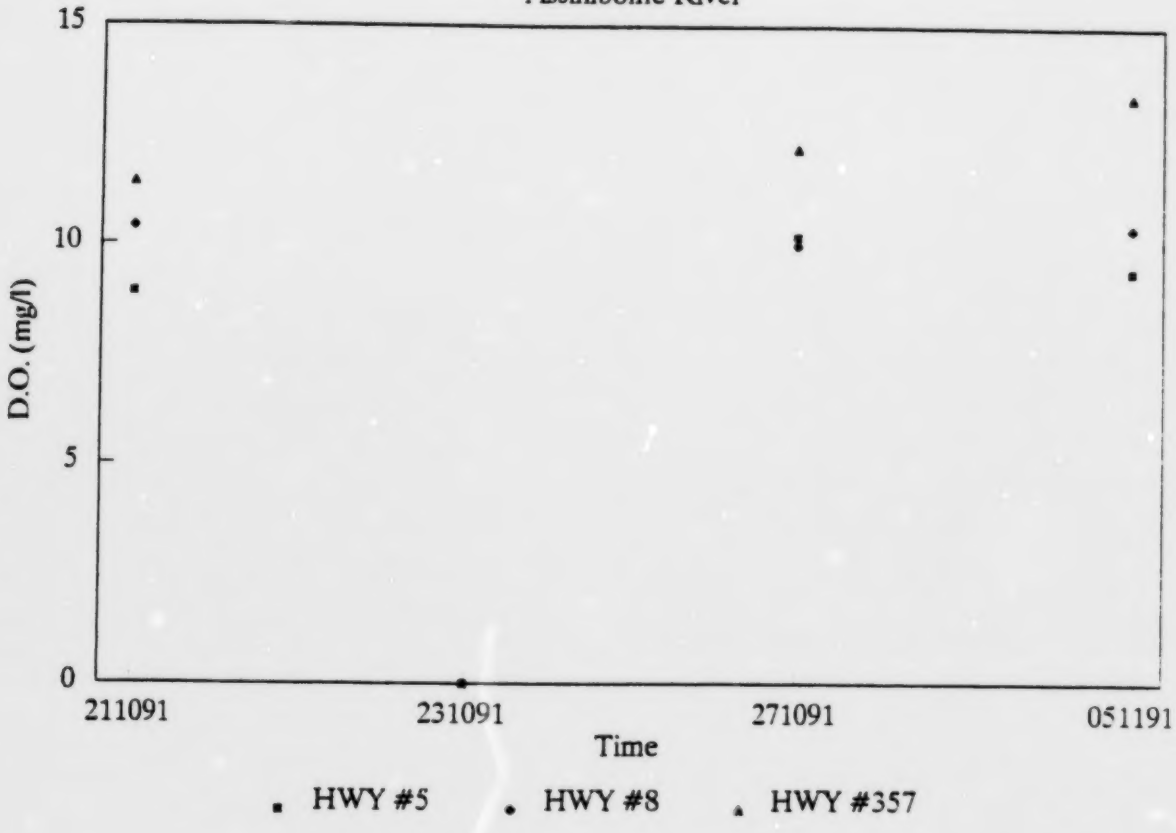
Assiniboine River



Analysis from Sask. Provincial Lab

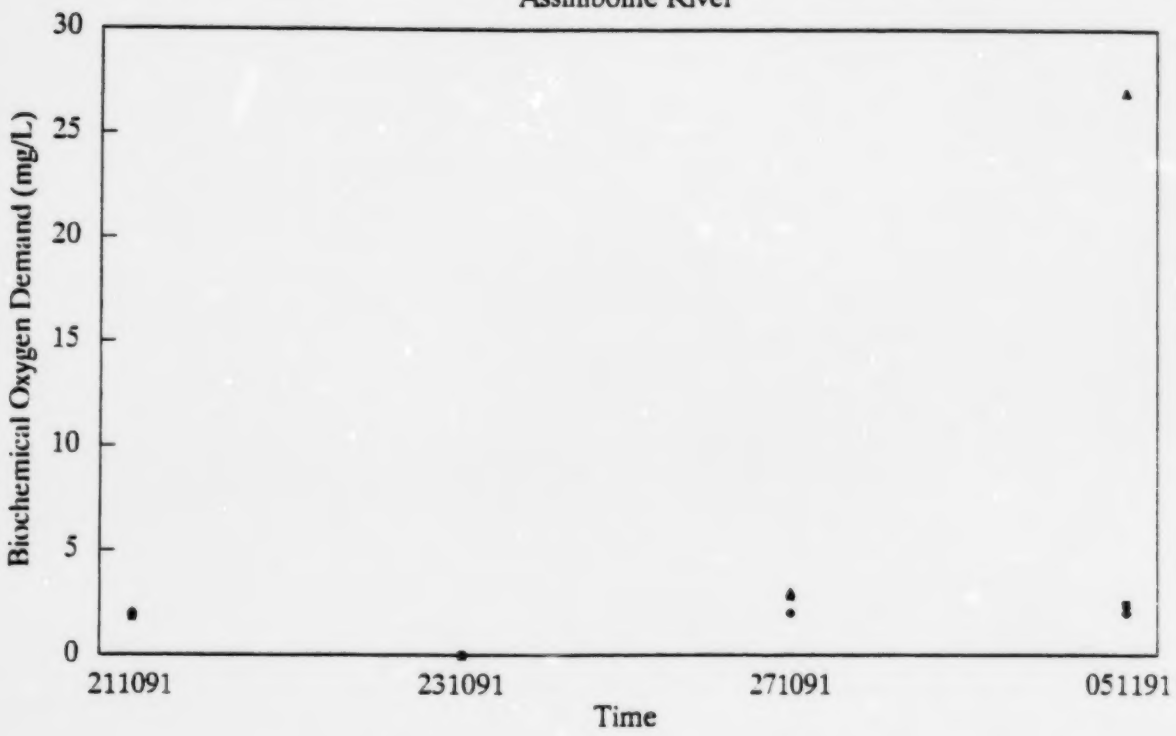
Dissolved Oxygen Versus Time

Assiniboine River



Biochemical Oxygen Demand Versus Time

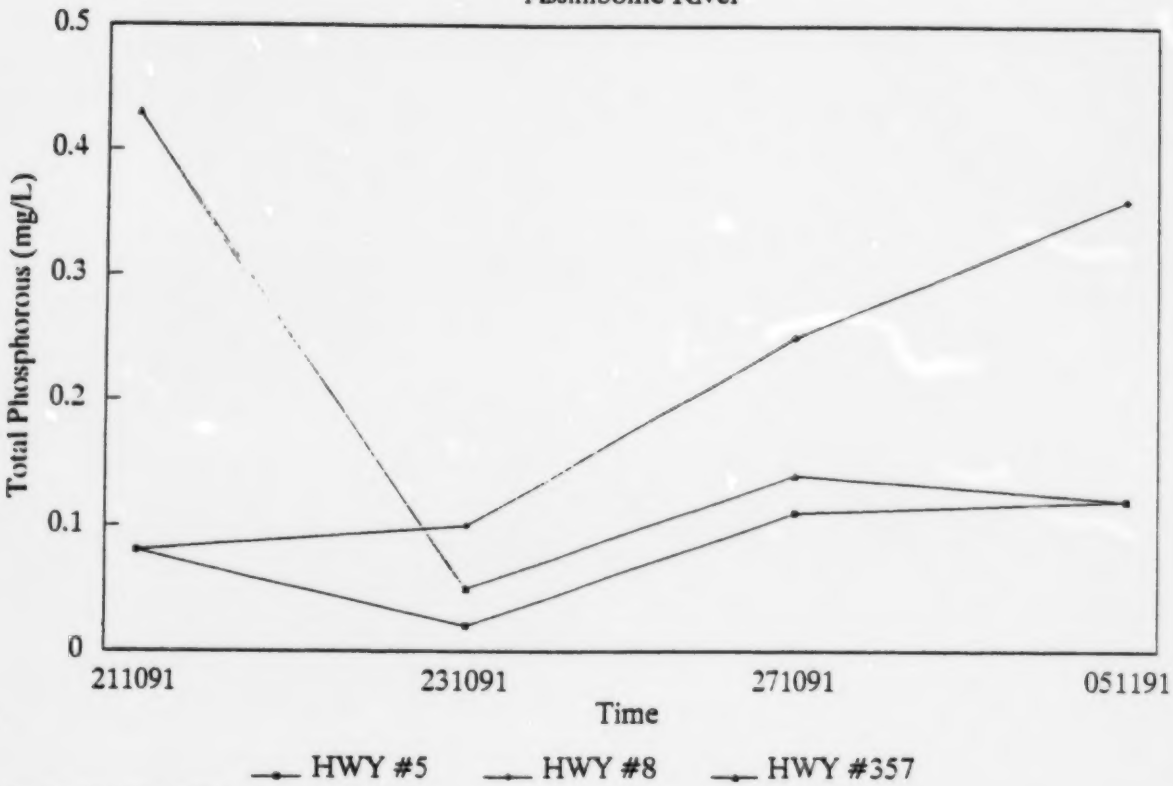
Assiniboine River



Analysis from Sask. Provincial Lab

Total Phosphorous Versus Time

Assiniboine River



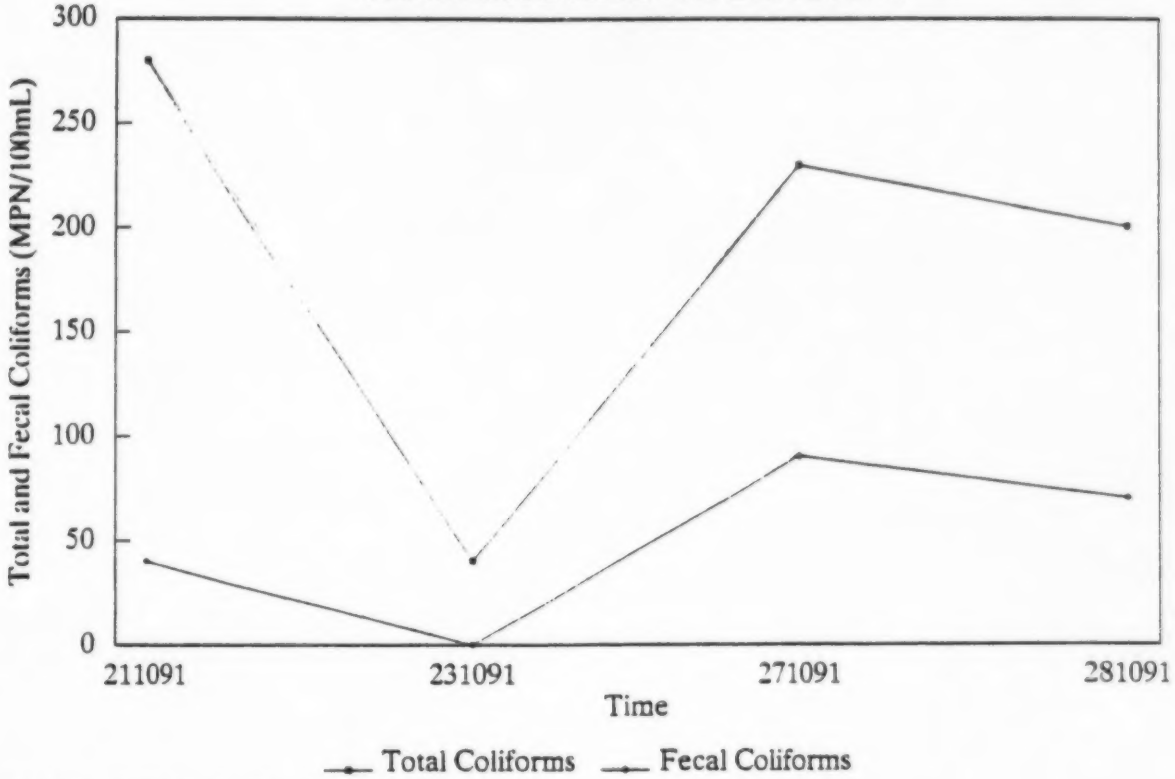
Analysis from Sask. Provincial Lab

APPENDIX 8

CONCENTRATION VERSUS TIME OF THE FALL KAMSACK FINAL EFFLUENT DATA

Total and Fecal Coliforms Versus Time

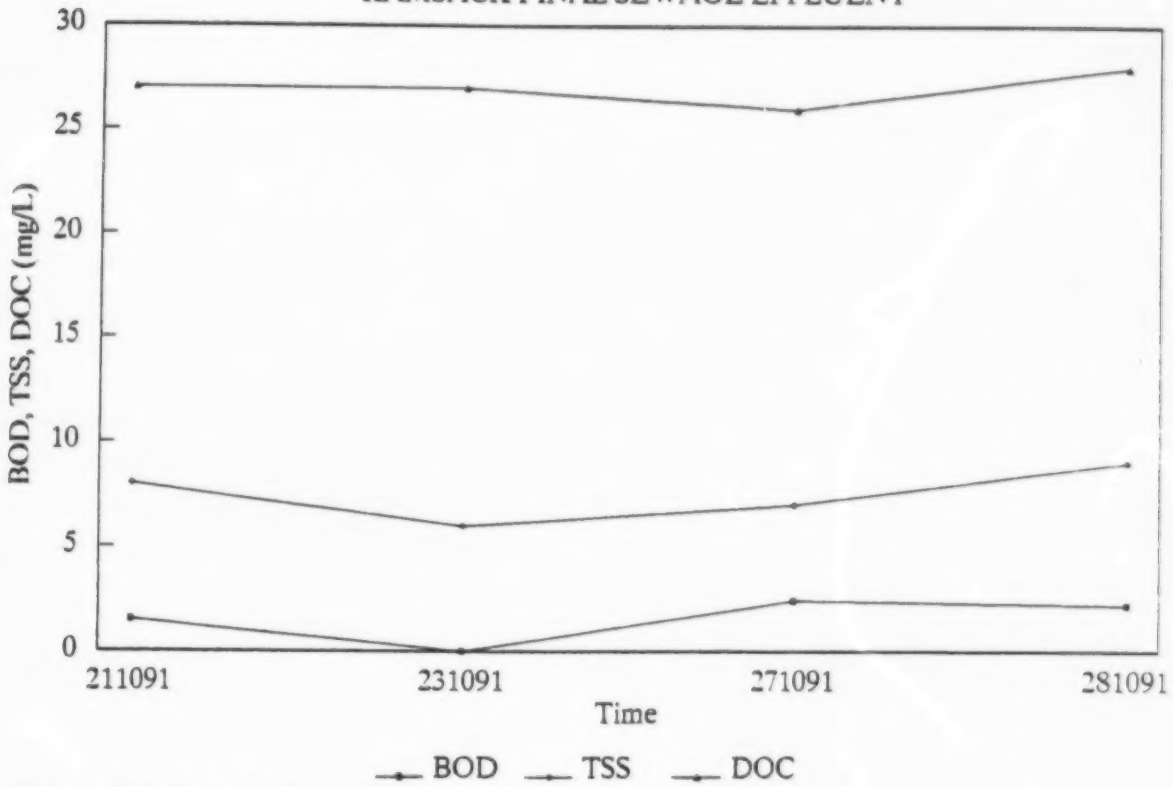
KAMSACK FINAL SEWAGE EFFLUENT



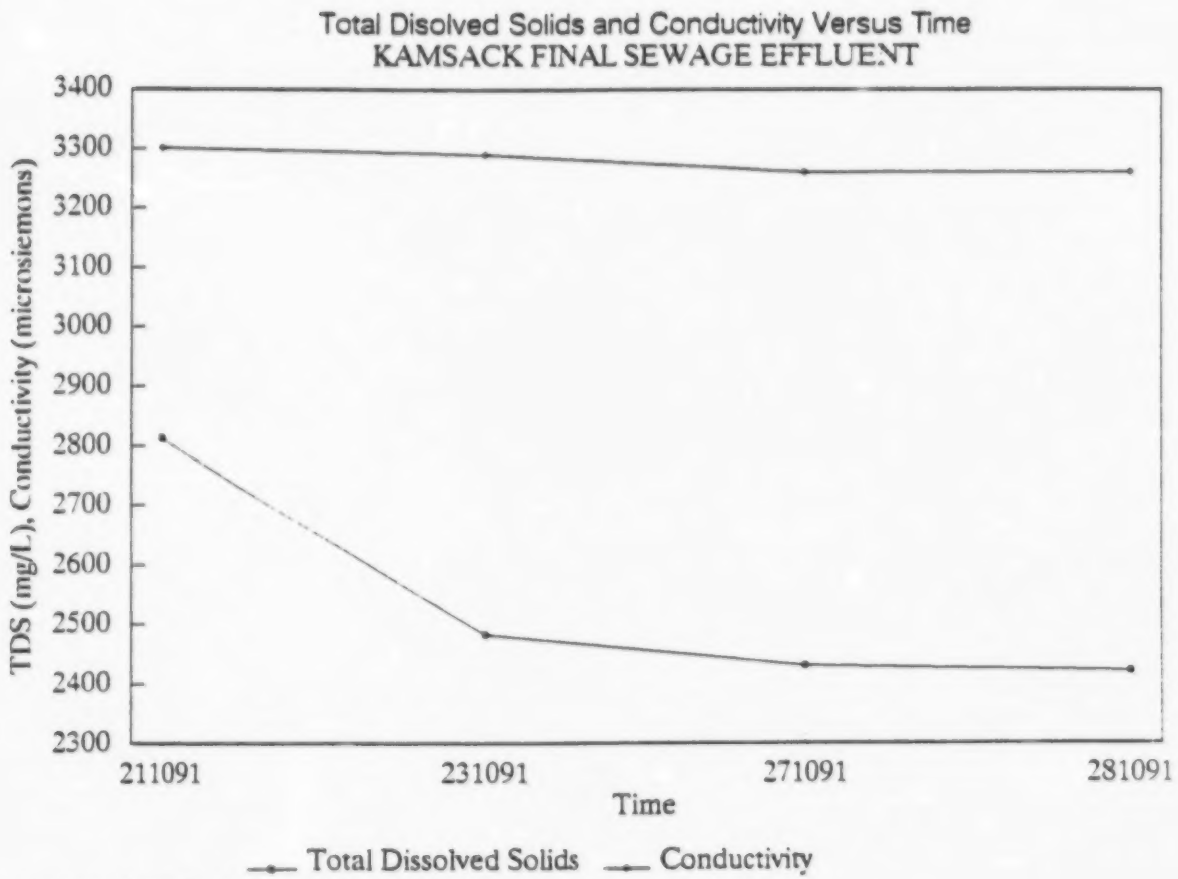
Analysis from Sask. Provincial Lab

BOD, TSS,DOC Versus Time

KAMSACK FINAL SEWAGE EFFLUENT



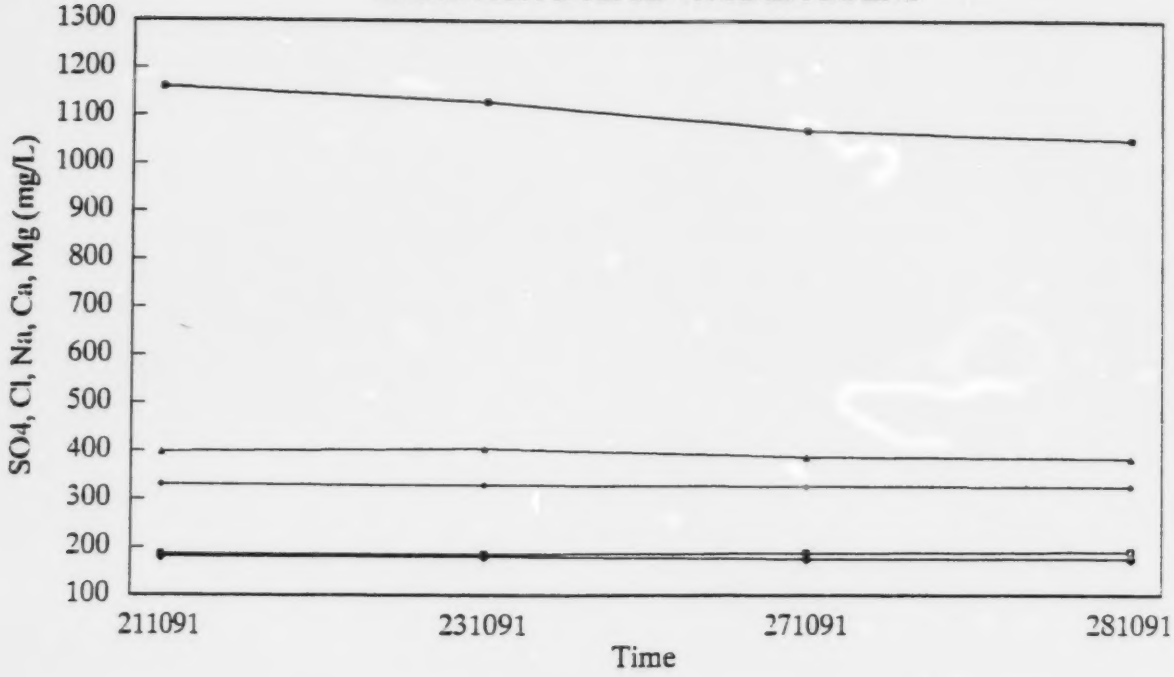
Analysis from Sask. Provincial Lab



Analysis from Sask. Provincial Lab

SO4, Cl, Na, Ca, Mg Versus Time

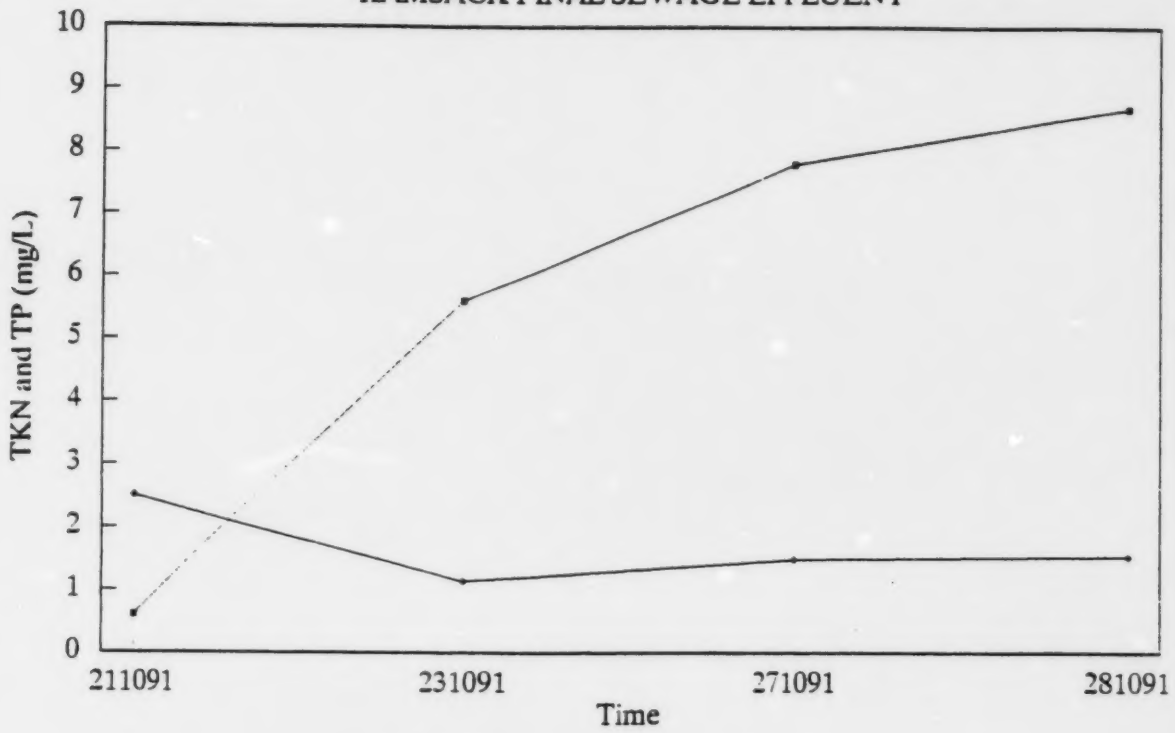
KAMSACK FINAL SEWAGE EFFLUENT



Analysis from Sask. Provincial Lab

TKN and TP Versus Time

KAMSACK FINAL SEWAGE EFFLUENT



Analysis from Sask. Provincial Lab

Appendix 9 Historical Kamsack Sewage Effluent Data Featuring Total Phosphorous

KAMSACK FINAL SEWAGE EFFLUENT		
DD/MM/YY	Sample Date (CST)	Total Phosphorous (MG/L)
03 07 79	1430	8.50
31 03 80	1700	8.50
22 07 80	1110	8.75
15 02 81	1600	10.00
18 10 81	1100	2.75
28 04 82	1530	8.00
19 07 82	1615	5.80
12 10 82	1400	3.75
04 05 83	1600	6.00
24 10 83	1300	5.10
10 04 84	1000	9.50
01 10 84	1330	2.20
23 04 85	1430	7.75
21 10 85	1700	3.00
28 04 86	0930	5.75
14 11 86	1330	2.50
17 05 88	1100	1.00
12 10 88	1100	1.25

* DATA FROM SEPS PROVINCIAL LAB